INVENTORY AND SURVEY OF SELECTED STREAM FISHERIES OF THE RED ROCK, RUBY, AND BEAVERHEAD RIVER DRAINAGES OF SOUTHWEST MONTANA; 2000 - 2002

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ABSTRACT

Trout population data are presented for seven study sections on the Beaverhead River. Trout populations of the upper river tailwater environment declined substantially in association with drought influenced declines in flow below the recommended minimum of 200 cfs. Brown trout populations suffered declines in density, standing crop, numbers of large fish, and condition similar to those experienced in prior drought episodes of the late 1980's and early 1990's. Brown trout populations in mid-river environments did not exhibit drought related declines in population, however brown trout condition was affected similar to upper river sections.. Lower river brown trout populations also exhibited declines in association with low flow regimes. Preliminary observations are presented on an Arctic grayling reintroduction effort in the lower Beaverhead River along with preliminary sampling of other native species populations including mountain whitefish, white and longnose sucker. Salmonid population data are presented for two study sections in the upper Ruby River. Trout populations declined substantially from drought influenced flows exhibiting reductions in density, standing crop, recruitment, and condition factor. Data are also presented describing Arctic grayling reintroduction efforts in the upper Ruby River. Trout population data are presented for 3 study sections sampled in the lower Ruby River system. The affects of a 1994 reservoir dewatering event on a limited tailwater fishery, the acquisition of public fishing access sites, and the affects of the recent drought on brown trout populations are discussed among the various study sections over the period of record. The trout populations of Poindexter Slough are presented for the study period. Brown trout population declines and recovery are discussed in regard to the discovery of whirling disease in the system. Population data for four study sections on Big Sheep Creek are presented and discussed relative to the discovery of whirling disease. Westslope cutthroat trout and brook trout population data are presented for Odell Creek relative to a habitat improvement project on a discreet reach of stream.

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INTRODUCTION

The mainstem river fisheries of the upper Missouri River drainage of southwest Montana are nationally renowned for their wild trout populations and "blue ribbon" fisheries. These river systems, first described by the Lewis and Clark expedition, also contain smaller tributary streams which provide high quality sport fisheries or support native fish populations in isolated settings. The popular sport fisheries of these drainages support relatively high angler use which has recently undergone a relatively substantial decline associated with severe drought conditions. Similar declines in angling pressure were observed in the drought episode of the late 1980's and early 1990's. This report details wild trout population dynamics in selected study sections of mainstem rivers and tributary streams in the Red Rock, Ruby, and Beaverhead River drainages of southwest Montana which were last described by Oswald (2000c). This report also includes population data for other native fish species including mountain whitefish and white and longnose sucker.

The streams of southwest Montana support a relatively limited diversity of native fish species to include westslope cutthroat trout; Arctic grayling; mountain whitefish; burbot; white, longnose, and mountain sucker; longnose dace, and mottled sculpin. Concern over the future of native fluvial Arctic grayling of the upper Missouri River system has led to recent grayling reintroduction projects beginning in 1997 in the upper Ruby River and in 1999 in the lower Beaverhead River (Oswald, 2000c). Concern over the future persistence of native westslope cutthroat trout has resulted in numerous studies of population genetics and hybridization, competition with introduced species, and habitat limitations. These studies have resulted in recent projects which have attempted to improve habitat quality, reduce competitive factors and expand westslope cutthroat trout distribution within the upper Missouri drainage (Oswald 1999 and 2000c). The popular sport fisheries of southwest Montana are largely based upon wild populations of introduced salmonids including the brown, rainbow, and brook trout as well as lesser tributary contributions of Yellowstone cutthroat trout or rainbow trout and their hybrids with native westslope cutthroat trout. Introduced nongame species include the red side shiner minnow and common carp which are present at low density in lower reaches of the mainstem river systems.

The Beaverhead River supports variable populations of brown and rainbow trout dependant upon dominant habitat type, regulated flow regimes, inverted lower river hydrograph, distance from the tailwater of Clark Canyon Dam, sediment loading, thermal regime, and riparian development. The Beaverhead River can be roughly bisected into upper and lower river reaches at the City of Dillon, Montana based on flow regime. The upper river reach generally depends upon irrigation and flood control releases from Clark Canyon Dam for its dominant flow regime which can result in an extremely productive "tailwater" reach between the dam and Barretts Diversion. A spring runoff component can be introduced in the reach from major tributaries such as Grasshopper and Blacktail Deer Creeks which can also augment base flow. Summer stream flows generally remain ample while winter flows can often exhibit critical low flows for the maintenance of fish habitat. The lower river reach exhibits an inverted hydrograph in which spring and summer flows are often minimal and winter months are characterized by a rising hydrograph as irrigation water drains from alluvial terrace formations surrounding the valley floor. Lower river tributaries

are largely representative of valley floor spring creeks or "sloughs" and are subject to the same inverted hydrograph as the river. The sport fishery of the Beaverhead River is dominated by brown trout while limited rainbow trout populations have been supported between Clark Canyon Dam and the city of Dillon, Montana. Beginning in 1999, an attempt has been made to reestablish an Arctic grayling population in the lower river between the mouth of Stodden Slough and the confluence of the Beaverhead and Big Hole Rivers. Past angler use of the Beaverhead River has been concentrated in the upper tailwater portions of the system between Clark Canyon Dam and Barretts Diversion. This concentrated use pattern has persisted to the present but estimated pressure had increased from 15,093 angler days in 1991 to 39,726 angler days in 1997 and 39,622 in 1999 (MFWP 1989-2001) with nonresident angler use accounting for about 63% of the total angler user days. In 2001, the Montana Fish Wildlife and Parks Commission established a Biennial Rule regulation which restricted float fishing use by commercial outfitters and nonresident anglers. This rule was renewed by the Commission for another two year period in 2003. Angling pressure in 2001 declined markedly to an estimated 14,574 angler days, however, the percent contribution of the nonresident angler component remained high at 62.2% of the total. The 2001 pressure was similar to that observed in the drought influenced 1991 estimate and declines were similar to those observed in other area rivers which suffered drought influenced flow regimes. Oswald (2000c) last described the salmonid populations of the Beaverhead River

The fisheries of the Ruby River can be examined as two systems also, i.e., a lower river and an upper river environment, roughly bisected by the Ruby Reservoir. The lower Ruby River supports relatively abundant populations of brown trout in habitats downstream from the Ruby Reservoir. The size composition and abundance of these populations is dependant upon distance from the reservoir tailwater, dominant habitat type and condition, and flow release regime from the dam. Upper Ruby River fisheries are dominated by brown and rainbow trout in relatively close proximity to the reservoir while upper reaches of the river are dominated by a hybridized swarm of rainbow trout and westslope cutthroat trout. Since 1997, attempts have been made to reintroduce a fluvial Arctic grayling population in the upper Ruby River. In 1994, a complete dewatering of Ruby Reservoir occurred (Oswald 2000a and 2000c) resulting in a significant fish kill in a limited reach of the Ruby River tailwater downstream from the dam. This event led to the formation of a Governor's Ruby River Task Force which investigated and recommended methods to promote adequate storage in Ruby Reservoir and adequate flow regimes for irrigation and fisheries in the Ruby River. In 1995, angler frustration over decreasing access to private lands along the lower Ruby River led to the formation of a Governor's Ruby River Fishing Access Task Force. Recommendations of this Task Force led to the formation of a Lower Ruby River Fishing Access Plan (MFWP 1996) and the ultimate acquisition of 5 public fishing access sites along the lower river corridor in 1996. Increased public access had an immediate affect on angling pressure within the lower Ruby River reach. In 1997, angling pressure on the lower Ruby was estimated at 9,458 angler days, a marked increase over the 1995 pressure estimate of 5,974 angler days (MFWP 1989-2001). Angling pressure continued to increase to an observed high of 13,996 angler days in 1999 but declined markedly to 9,162 in 2001. Similar to the Beaverhead River, nonresident anglers composed 62.6% and 64% of the 1999 and 2001 angling pressure, respectively. Angling pressure in the upper Ruby River has historically remained relatively low despite an abundance of public ownership on Beaverhead National Forest lands. Pressure

estimates from 1989 through 1995 averaged 685 angler days per year with an observed maximum of 862 in 1991. Similar to trends in other area rivers, angling pressure increased sharply to 1,591 and 1,252 angler days in 1997 and 1999 but declined under the influence of drought impacted flows to 763 angler days in 2001. Fish population data for both the upper and lower reaches of the Ruby River were last reported by Oswald (2000c).

Poindexter Slough is a major public spring creek fisheries resource. It is tributary to the Beaverhead River and is located in close proximity to the city of Dillon, Montana. While base flows of Poindexter Slough are maintained through accretions from numerous valley floor spring sources, a portion of the stream's summer flow consists of irrigation water diverted from the Beaverhead River. The fishery of Poindexter Slough is dominated by wild brown trout which attain extremely high density due to an abundance of favorable spawning and rearing habitat. Much of the productive fisheries reach of Poindexter Slough is located on public fishing access property maintained by MFWP. Recent angling pressure estimates indicate a use rate of approximately 3,000 angler days per year through 1999 (MFWP 1989 - 2001). Unlike most other area waters, Poindexter Slough has maintained a relatively stable base flow from spring sources despite severe drought conditions. As a result, angling pressure increased in 2001 to an observed high of 4,095 angler days. The brown trout populations of Poindexter Slough were last described by Oswald (2000c).

Big Sheep Creek is a productive mountain tributary stream which flows into the Red Rock River near Dell, Montana. The stream enlarges markedly beyond headwater tributary inflow due to a large spring flow influence originating from a porous limestone formation. The stream has produced relatively abundant populations of large rainbow and brown trout in the recent past. Big Sheep Creek also supports limited numbers of westslope cutthroat trout which originate in headwater tributary environments. The stream recently supported relatively heavy angling pressure estimated at 1,661 angler days in 1997 and 1,226 angler days in 1999 which had since declined to an estimated 785 angler days in 2001 (MFWP 1989 - 2001).

In recent years, much effort has been directed at the native westslope cutthroat trout populations of the upper Missouri River drainage. The majority of these populations exist in relatively isolated first or second order mountain tributary streams. Sampling efforts have been directed at locating relict populations and determining their genetic composition to ascertain purity or degree of hybridization from introduced rainbow and Yellowstone cutthroat trout (Oswald 2000c). Some effort has also been made to improve degraded habitats within discreet stream systems. In channel work performed by U.S. Fish and Wildlife Service in Odell Creek, a Red Rock River Tributary is an example of a habitat restoration effort. In addition to hybridization and habitat degradation, competition from introduced salmonids, particularly brook trout, has resulted in a limited distribution for the native westslope cutthroat trout in the upper Missouri River drainage.

METHODS

Trout populations in rivers and large streams were sampled through the use of electrofishing techniques based on mark-recapture methodologies described by Vincent (1971). Electrofishing was conducted via boat mounted, mobile anode techniques which utilize a 3500

watt generator and Leach type rectifying box. A straight or continuous wave DC current is used at 1,000 to 1,800 watts. Fish captured within the field were drawn to the boat, netted, and deposited into a live car. Boats consisted of a modified Clackacraft drift boat or modified Coleman Crawdad boat depending upon stream size. Individual fish captured were anesthetized, segregated by species, measured for length and weight, marked with a small identifying fin clip, and released. Scale samples for age determination were collected from a representative subsample by length. A single Marking run was made through each study section followed by a single Recapture run approximately 12 to 14 days later.

Trout population statistics were analyzed under a log-likelihood methodology developed and described by Montana Fish, Wildlife and Parks (1994) under guidelines presented by Brittain, Lere, and McFarland (1998). Population estimates were largely calculated for brown trout from March and April samples collected from the study sections while rainbow trout, cutthroat trout, and Arctic grayling population estimates were calculated from September and October samples. The seasonal segregation by species was applied to avoid population estimate bias due to spawning movements and migrations.

RESULTS

UPPER BEAVERHEAD RIVER

Flow Regime

Persistent drought conditions and resultant low storage pools have dominated the past three years in Clark Canyon Reservoir (Figure 1). The present storage situation is similar to that experienced during the 1989 - 1992 period which resulted in extremely low over winter flow releases into the Beaverhead River and subsequent losses in trout populations (Oswald 1990, Oswald and Brammer 1993). Figure 2 demonstrates the affects of low overwinter dam releases on flows in the upper Beaverhead River and compares those flows with the Minimum Recommended Instream Flow (MFWP 1989) for the reach. Despite the appearance of relatively ample reservoir storage over most of the period, overwinter flows in the upper Beaverhead River have dropped below the recommended minimum in 11 of the 20 years depicted. In most of those years, flow dropped substantially below the recommended minimum resulting in significantly reduced wetted perimeter and substantial reductions in fish habitat availability and niche diversity. In the 2002 and 2003 water years, flow releases averaged only 35 and 28 cfs, respectively. In each of those years, flow reductions occurred in early September and did not improve until early May. Flow accretions throughout the system improved flows as distance downstream from the dam increased but were insufficient to increase flow to the recommended minimum between the dam and the City of Dillon in either year.

Hildreth Study Section

Brown trout population density and standing crop are presented in Figure 3 for the 1986 through 2002 period. Brown trout density and, particularly standing crop, have declined with low

winter flow regimes over the 2000 - 2002 period. While brown trout population density declined from the observed highs which exceeded 2,100 Age II and older fish per mile in 1998 and 1999, it remained relatively stable in the succeeding two years. Brown trout standing crop, however, has declined in a linear fashion throughout the 2000 - 2002 period. This trend in both density and standing crop was similar to that observed in response to the drought limited flow regimes of the 1990 - 1994 period although the slope of the decline in biomass was more sharply defined in the recent episode as losses in standing crop exceeded 1,000 pounds per mile over the 1999 - 2002 period. The steep declines in brown trout biomass were correlated directly with substantial losses in numbers of older, larger fish. Numbers of 18 inch and larger brown trout (Figure 4) soared to 832 per mile in 1999 following ample flow regimes (Figure 2) but had declined, in a steep linear fashion, to 399 per mile by 2002. Similar observations can be made, in more dramatic fashion, for 20 inch and larger brown trout (Figure 5) which largely compose the Age V and older segment of the population. During the low winter flow regimes of the 1988 - 1991 and 1999 - 2002 periods record high numbers of these older larger fish declined markedly in a very linear fashion. Observed highs for these large fish occurred in 1988 and 1999 following periods of abundant flow. Densities of 22 inch and larger brown trout (Figure 6) remained low while declining slightly from 1998 - 2000 levels of abundance. Unlike the 18 inch and 20 inch and larger fish they did not rise to match or exceed high densities observed in 1988. Oswald (2000c) noted that brown trout growth and ultimate size in the upper Beaverhead River had declined under recorded high population density and brown trout standing crop. Brown trout Condition Factor (K) over the recent period of declining stream flow is depicted in Figure 7. Mean population Condition for Age II and older brown trout declined slowly over the past four years to a relatively low value of 32.35 for the upper Beaverhead River tailwater. Condition for 18 inch and larger and 20 inch and larger fish declined more steeply and more severely, with increased length and age. The 20 inch and larger fish declined to a mean Condition of 28.97 by 2002. Similar relationships between overwinter flow and brown trout Condition Factor were depicted under the low overwinter flow regimes of the 1988 - 1990 period by Oswald (1990) and Oswald and Brammer (1993).

Trends in rainbow trout density and standing crop over the 1986-2000 period are presented in Figure 8. Due to extremely low fall flows, rainbow trout population estimates were not conducted in 2001 or 2002. While brown trout density and standing crop soared and declined with rising and falling flow regimes over the recent past, rainbow trout numbers and biomass underwent a slight increasing trend over the recent, 1996-2000 period. Recent rainbow trout density has averaged approximately 25% of the observed brown trout density at approximately 500 per mile. Densities of larger rainbow trout are presented in Figure 9. As was the case with population density and standing crop, numbers of 18 inch and 20 inch and larger fish exhibited an increasing trend over the 1996 - 2000 period of study.

Pipe Organ Study Section

Brown trout population trends are presented in Figure 10 for the 1986-2002 period of study in the Pipe Organ Section. Brown trout density and standing crop declined from an observed high of 1999 with low flow regimes experienced in the 2000 - 2002 period. Unlike the situation in the Hildreth Section, the decline in standing crop was not linear due to a relatively

strong recruitment of Age II fish in the 2001 sample. As a result of this recruitment, brown trout density actually increased in 2001.Similar to the Hildreth Section, numbers of larger brown trout (Figure 11) declined in a steep linear fashion from 1999 to 2002. Numbers of these 18 inch and larger fish also declined substantially in 1991 and remained low over the 1991-1995 period during similar low flow regimes. Mean brown trout Condition Factor (Figure 12) also declined at low flow over the 1999 - 2002 period although not as steeply as that observed for the Hildreth Section. Mean Condition of the older 18 inch and larger fish declined much more dramatically than that of the general population.

Fish and Game Study Section

Fish and Game Section brown trout population trends are depicted in Figure 13 for the 1988-2002 period of study. Similar to the Hildreth and Pipe Organ Study Sections, brown trout density and standing crop peaked at high levels in 1998 following a period of abundant flow. The 2000 - 2002 trend, however differed markedly from that observed in either of the two upstream study sections with both density and standing crop maintaining stable or increasing trends despite poor flow regimes. While overwinter flows in the Fish and Game Section were not as severely reduced as those in the upper tailwater, low flow regimes still dominated the reach over the recent study period. September flows as low as 67.6 cfs in 2000 and 44.5 cfs in 2001 were measured at the head of the study section after dam releases from Clark Canyon Reservoir were reduced for the winter. The high standing crops of the 1998 - 2002 period were correlated directly with increasing numbers of 16 inch and larger fish (Figure 14). Numbers of 16.0 - 17.9 inch fish and numbers of 18 inch and larger fish attained the highest observed densities over the 1988 - 2002 period of study. While the density, standing crop, and numbers of older, larger brown trout remained high despite low flow regimes, brown trout Condition Factor declined (Figure 15) similar to the situation observed in both the Hildreth and Pipe Organ Sections over the 1998 - 2002 period.

Low Flow Study Section

Brown trout trends in population density and standing crop are exhibited in Figure 16 for the Low Flow Section over the 1987-2000 period of study. Brown trout density and standing crop increased slightly in the 2000 sample but remained far lower than populations observed in the late 1980's. Since 1994, density and standing crop have remained far below recorded highs and did not appear to recover with the abundant flow regimes of the 1995 - 1999 period. While standing crop in the Low Flow Section has averaged slightly lower than that observed for the Fish and Game Section, density has generally averaged somewhat higher (Oswald 2000c). Recent samples in 1998 and 2000 exhibit a greater difference between the two study sections for both parameters, however. Length distribution within the Low Flow brown trout population (Figure 17) indicates that the section generally supported higher densities of smaller fish than the Fish and Game Section. Recent population estimates are indicative of below average recruitment into the population despite abundant flow regimes and ample habitat availability.

LOWER BEAVERHEAD RIVER

Flow Regime

The lower Beaverhead River can generally be classified as the reach between the City of Dillon, Montana and the mouth of the river at its confluence with the Big Hole River. The majority of the spring and summer flow released from Clark Canyon Reservoir is diverted into major irrigation canals located between the dam and Dillon. The river gage in Dillon is often managed as the low flow point in the system with valley floor springs and irrigation return flow and seepage left to provide irrigation water and instream flow throughout the remainder of the system. As such, spring and summer flow regimes are often quite low while fall and winter usually is marked by an ascending hydrograph as irrigation water drains into the valley floor. This phenomenon is often described as an inverted hydrograph. Low summer flows within the lower river reach are depicted in Figure 18. With the exception of 1993 and the 1995 - 1999 period, both very wet climatic episodes, the overall 1988 - 2002 period was marked by extremely low July and August streamflows. In association with a decrease in elevation down the gradient of the valley floor, the low flow regimes of July and August are often accompanied by high thermal regimes (USGS 1988 - 2002). The recent period of study, 2000 - 2002 exhibited little difference between July and August mean flow regimes, both of which fell substantially below the Minimum Recommended Flow of 200 cfs for the reach during all three years.

Anderson Study Section

Brown trout population trends for the Anderson Section are presented in Figure 19 for the 1991-2002 period of study. Brown trout populations within the Anderson Section have remained at low density when compared with upper river reaches. Population density has varied between approximately 300 and 450 fish per mile with a standing crop of about 300 to 400 pounds per mile. The recent period of study, 2000 - 2002, has exhibited declining trends in both density and standing crop although the decline in density has been more marked than that observed for biomass. This pattern was similar to that observed for the 1992 - 1994 period which was also marked and preceded by chronic low summer flow regimes (Figure 18). Length distribution within the population (Figure 20) indicated that recruitment has suffered at low flow regimes over the recent past while populations were reflective of relatively high percentages of larger fish at low population density.

Beginning in 1999, fluvial Arctic grayling were reintroduced to the lower Beaverhead River via annual plants of overwintered yearling fish (Magee 2003). These plants continued through 2002 and were temporarily discontinued for further evaluation in 2003. One of the plant locations was the Anderson Lane Bridge which is the upstream boundary of the study section. Due to this reintroduction effort, attempts have been made to estimate the grayling population within the section in the fall and spring sampling efforts of 1999 - 2002 period of study. To date, no reliable population estimate has been calculated for the Anderson Section. In lieu of population estimates, catch per unit effort data is presented for Arctic grayling in Figure 24. The more ample flow regimes of 1999 clearly resulted in a relatively abundant survival of fish throughout the

summer while declining summer flows in the 2000 - 2002 period resulted in poor survival to the first fall. Differential capture between fall and spring samples is also indicative of poor overwinter survival and possibly, out migration of fish during their first year following introduction. Oswald (2000c) and Magee (2002) noted poor overwinter survival of introduced Arctic grayling in the upper Ruby River and also documented downstream migration of yearling grayling from the Anderson Study Section of the lower Beaverhead River in fall samples.

Recent introductions of Arctic grayling into the lower Beaverhead River have triggered an interest in the population dynamics of other native fish species. As a result, a population estimate for Age II and older mountain whitefish was included in the spring 2002 Anderson Section sampling effort (Figure 22). The initial sample revealed a whitefish population of approximately 420 fish per mile representing a standing crop of slightly less than 500 pounds per mile. The estimated density of whitefish was similar to maximum densities observed for brown trout while the standing crop slightly exceeded the highest observed for brown trout for the study section. Length frequency analysis (Figure 23) of the whitefish sample revealed a distribution among numerous age classes with a dominance by larger, Age IV and older fish. This situation was similar to that observed for the brown trout population.

Additional native species sampling in the Anderson Section included fall sampling of white and longnose sucker. While insufficient numbers of either species was captured to calculate a valid population estimate, catch per unit effort data is depicted in Figure 24. The data indicate that neither species was particularly abundant in the study section compared to brown trout or mountain whitefish sample densities. The data also indicate that the longnose sucker was substantially less abundant than the white sucker. Length frequency analyses for both species of sucker are depicted in Figures 25 and 26 for the 2001 - 2002 sample period. The data indicated that the sample populations were dominated by juvenile fish of both species and suggest that numbers of adult fish were significantly reduced by Age III or Age IV in both populations in the study section.

Mule Shoe Study Section

Brown trout population trends for the Mule Shoe Section are depicted in Figure 27 for the 1990-2002 period of study. Brown trout populations in the Mule Shoe Study Section have remained at low density and low standing crop throughout the study period (Oswald and Brammer 1993). The recent 2000 - 2002 period of study began to exhibit similar declines in density and biomass to those observed in the Anderson Section upstream and also exhibited a similarity to the 1992 - 1994 period of study in both sections. The 2002 Mule Shoe sample, however, revealed a population density and standing crop higher than any observed in prior samples within the study section. Length analysis of the brown trout populations of the section (Figure 28) indicate that relatively high population densities observed in 2002 was based on relatively strong recruitment of Age II fish and high numbers of older larger fish. With the exception of the 1990 sample, the brown trout population of the Mule Shoe Section has not been marked by a relatively high percentage of large brown trout as has often been the case in the Anderson Section.

Similar to the Anderson Section, the Mule Shoe Section was selected as a reintroduction

site for yearling fluvial Arctic grayling over the 1999 - 2002 period (Oswald 2000c, Magee 2002). Due to this reintroduction effort, attempts have been made to estimate grayling density in fall samples since 1999. Similar to observations made in the Anderson Section, completion of statistically valid population estimates for the Mule Shoe grayling have been frustrated by low population sample numbers and migration of fish through the study section. Catch per unit effort data for Arctic grayling are depicted in Figure 29 for the Mule Shoe Section. As was the case in the Anderson Section, the data are indicative of poor summer survival and poor overwinter survival of the planted grayling in the lower Beaverhead River. Similar to the 2002 fall sample for brown trout, abundance of Arctic grayling improved in the fall of 2002 with numbers sufficient to estimate the population. The resultant population estimate revealed a density and standing crop of 48 fish and 16.9 pounds per mile. All of the grayling in the estimated population and sample were Age I fish originating from the 2002 summer plant.

A mountain whitefish population estimate was added to the 2002 spring sample (Figure 30) in the Mule Shoe Section. Mountain whitefish density and standing crop exceeded 500 fish and 500 pounds per mile which slightly exceeded those parameters for brown trout in the study section and exceeded the estimated whitefish population in the Anderson Section. Length frequency analysis revealed a sample population similar to that observed in the Anderson Section and similarly skewed toward larger Age IV and older fish.

White and longnose sucker were added to the fall sampling program in 2001 and 2002 (Figures 32 and 34) with resultant population estimates obtained for both species in 2001 and white sucker in 2002. White sucker density (Figure 32) increased markedly between 2001 and 2002 more than doubling to exceed 800 Age I and older fish per mile while standing crop remained static at about 280 to 290 pounds per mile. Length frequency analysis (Figure 33) demonstrated that most of the population increase between 2001 and 2002 was due to very strong recruitment of Age fish and relatively strong survival of Age II fish in the population. Longnose sucker were estimated at a density of 98 fish per mile supporting a standing crop of 113 pounds per mile in 2001 (Figure 34). In contrast with the white sucker, length frequency analysis (Figure 35) indicated that most of the longnose sucker in both the 2001 and 2002 samples were older, larger fish which appeared to represent a single cohort.

Silver Bow Study Section

Fisheries data for the Twin Bridges Study Section of the Beaverhead River was last presented by Oswald (2000c). In order to better monitor the affects of fishing access, stream flow, and Arctic grayling introductions in the lower Beaverhead River, the Silver Bow Study Section was selected and sampling initiated in fall 2000. The Silver Bow Section originates on the Giem Ranch near Twin Bridges, Montana (T4S, R6W, SW1/4, SW1/4 Section 20) and terminates on a section of land managed by the State of Montana, Department of Natural Resources (T4S, R6W, NE1/4, SW1/4 Section 16). Silver Bow Lane, a Madison County road, crosses the river near mid study section at the Giem Ranch headquarters. The study section is 13,200 feet (2.5 miles) in length and is predominately a meandered alternating riffle pool habitat type (Type C, Rosgen) with poorly developed riparian vegetation and numerous actively eroding banks. The substrate is dominated by fines and summer flow regimes often drop significantly below those depicted in

Figure 18.

The brown trout population of the Silver Bow Section is depicted in Figure 36 for the 2001 and 2002 spring samples. Typical of lower Beaverhead River study sections, both density and standing crop for brown trout were relatively low. Both density and standing crop fell below any population estimate conducted in the Anderson Section and were similar to the range of the lowest observed parameters for the Mule Shoe Section. Population estimates conducted in the downstream Twin Bridges Section below the mouth of the Ruby River also exceeded the 2001 - 2002 Silver Bow Section estimates (Oswald 2000c). Length distribution within the 2001 and 2002 Silver Bow brown trout populations is depicted in Figure 37. A relatively strong cohort of 13.0 - 15.9 inch fish in 2001 resulted in improved densities of 16 inch and larger fish in 2002. Recruitment of Age II fish was relatively weak in both years at less than 100 fish per mile.

Arctic grayling plants were initiated in the Silver Bow Section in 1999 with release points at the Silver Bow Lane Bridge and downstream locations on State Land (Magee 2002). Sampling for introduced Arctic grayling was begun in the Silver Bow Section in fall 2000 and continued through 2002 (Figure 38). As was the case in both the Anderson and Mule Shoe Sections, Arctic grayling numbers remained low through the 2000 - 2002 period and were indicative of poor overwinter survival. Similar to the Mule Shoe Section, the fall 2002 sample yielded a valid population estimate of 14 fish per mile representing 4.9 pounds per mile standing crop. The estimate was for yearling Arctic grayling originating from the 2002 plant with a single fish in the sample representing an Age II grayling from the prior year's plant.

Mountain Whitefish sampling was initiated in the Silver Bow Section in the spring 2002 sample (Figure 39). The estimated density of mountain whitefish in the Silver Bow Section substantially exceeded those observed for both the Anderson and Mule Shoe Sections at nearly 700 fish per mile. Despite high whitefish density, however, standing crop was lower than that observed in either of the upstream study sections at slightly more than 100 pounds per mile. Length frequency analysis of the sample (Figure 40) indicated that most of the fish in the population were Age II or older juveniles less than 15 inches in length. Most of the fish in the Anderson and Mule Shoe Sections were older fish in excess of 15 inches in length. Comparisons of length frequency distribution with the Anderson and Mule Shoe Sections suggest that growth may be somewhat limited for mountain whitefish in the Silver Bow Section.

White and longnose sucker populations were sampled in fall efforts in the Silver Bow Section in 2001 and 2002. White sucker population (Figure 41) density and standing crop far exceeded that estimated for the Mule Shoe Section in 2001 but declined substantially in 2002. Length frequency analysis of the sample (Figure 42) indicated that recruitment of Age I and II fish remained abundant and somewhat similar between 2001 and 2002 but numbers of 14 inch and larger fish declined dramatically between the two years. Longnose sucker populations (Figures 43 and 44) declined dramatically between 2001 and 2002 with losses in the larger 12.0 - 17.0 inch fish. Longnose sucker density, biomass, and length frequency distribution were extremely similar to those observed in the Mule Shoe Section as was the population decline from 2001 to 2002.

UPPER RUBY RIVER

Flow Regime

The upper Ruby River can be classified as the approximate 40 mile mainstem river reach upstream from the Ruby Reservoir. This headwater system is composed of myriad tributaries entering from the Gravelly, Snowcrest, and Ruby Mountains. Most of the upper watershed is located on National Forest Lands, and, as such, is not as affected by irrigation as much as most of the valley floor river systems of southwest Montana. Mean August streamflow for the 1986 - 2002 period is depicted in Figure 45 and compared with the Minimum Recommended Instream Flow. Despite relatively low irrigation demand upstream from Ruby Reservoir, 9 of the past 17 years have exhibited summer flow regimes which failed to meet the Minimum Instream Flow Recommendation of 102 cfs. As has been the case for other southwest Montana Rivers, drought streamflows have dominated the 1988 - 1994 period as well as the current 2000 - 2002 period with a comparatively brief period of relatively ample flow dominating the 1995 - 1999 period.

Three Forks Study Section

The Three Forks Section typifies headwater environments of the upper Ruby River. The trout population of the Three Forks Section is composed of a hybrid swarm of rainbow trout, westslope cutthroat trout, and the hybridized progeny of both species. Due to the difficulty of visually separating individual fish, population data are analyzed as rainbow x cutthroat hybrid trout. Population data for the Three Forks Section are depicted in Figure 46 for the 1987-2002 period of study. Rainbow x cutthroat hybrid densities and standing crops declined dramatically over the 2000 - 2002 period from highs recorded in 1999. This pattern of population decline with declining streamflows in the recent past was remarkably similar to that observed over the 1987 - 1991 period of study in the section. Length group analysis of the population (Figure 47) revealed that high densities of older, larger fish observed in 1999 and 2000 had eroded under reduced flow regime while recruitment of juvenile fish has also suffered. Mean condition factor of rainbow x cutthroat trout in the Three Forks Section is depicted in Figure 48 for the study period. The recent 2000 - 2002 study period has exhibited a continued decline in average Condition Factor with declining summer flow from highs observed in the 1995 - 1997 period.

In 1997, an attempt to reintroduce fluvial Arctic grayling into the upper Ruby River was initiated with a plant of 29,805 young of the year fish in late summer. These fish were very small and survival was documented into October 1997 with the capture of 31 2.0-3.3 inch fish in the Three Forks Section. Subsequent sampling documented low winter survival of these young of the year plants. In 1998 and 1999, the upper Ruby River received plants of 9,804 and 7,349 overwintered yearling grayling to increase survivability. Subsequent plants of yearling grayling were continued through 2001. The estimated density and standing crop of Arctic grayling in the Three Forks Section is depicted in Figure 49 for the 1998 - 2002 period of study. The 1998 population estimate of 406 fish per mile was composed entirely of Age I fish and exceeded the density of the wild rainbow x cutthroat trout (Figure 22) by 104 fish per mile. The vast majority of fish in 1998 appeared to originate from the 1998 yearling plant with very few individuals

suspected of being survivors of the 1997 plant. The 1999 population estimate of 292 grayling per mile represented in a decline in the number of fish planted in 1999 and was dominated by yearling fish. Standing crop in both years approximated 100 pounds per mile indicative of larger sized yearling plants in 1999 and the presence of Age II fish in the population. Subsequent samples have shown a marked decrease in grayling survival with decreasing flow regime, diminished planting efforts and high overwinter mortality. Wild reproduction of grayling has been documented but recruitment has been very limited due to low survival of stocked fish to reproductive adulthood. Mean length, weight, and condition factor for Arctic grayling in the Three Forks Section are presented in Table 1. Mean length, weight, and condition factor varied between 1998 and 2002

Table 1. Mean length (inches), weight (pounds), and Condition Factor (K) for Arctic grayling collected in the Three Forks Section of the Ruby River 1998 - 2000.

Year	Mean Length	Mean Weight	Condition Factor (K)
1998	9.8	0.28	29.60
1999	10.5	0.35	30.06
2000	8.1	0.18	31.60
2001	9.6	0.28	31.34
2002	10.8	0.42	30.53

dependant upon differences among plants, contribution of wild progeny and Age II and older plant survivors, and prevailing habitat conditions. Oswald (2000c) noted increasing grayling size between 1998 and 1999 despite the high density and standing crop impressed upon the habitat via the Arctic grayling plants. Moreover, grayling size increased as rainbow x cutthroat trout density and standing crop reached very high levels for the study section (Figure 46) while maintaining a high mean condition factor (Figure 48) under ample flow regimes. Subsequent declines in average size in 2000 and increases in 2002 reflect differential plant sizes but also resulted from the inclusion of wild progeny into the population in 2000 and increased contribution of Age II and older fish in 2002. Wild young of the year grayling were collected in fall samples in the Three Forks Section in 2000 and 2002 while suspected wild yearling fish were collected in the 2001 sample.

Greenhorn Study Section

The Greenhorn Section is typical of lower reach habitats of the upper Ruby River system with trout populations of the reach dominated by brown and rainbow trout. Rainbow trout density and standing crop are depicted for the Greenhorn Section in Figure 50 for the 1990-2002 period of study. The section has supported relatively low densities of Age I and older rainbow trout which peaked with strong flow regimes in 1998 - 1999. Similarly, rainbow trout standing crop in

the Greenhorn Section peaked in 1999 at more than 130 pounds per mile. Since 1999, both density and standing crop have declined, in a very steep and linear fashion, to observed lows for the sampling history of the study section. In addition to the declines in rainbow trout density and standing crop, rainbow trout recruitment (Figure 51) was lacking over the recent 2000 - 2002 period. Oswald (2000c) observed that the 1999 rainbow trout population also lacked any discernible juvenile recruitment in the length distribution analysis.

Brown trout densities and standing crops within the Greenhorn Section are portrayed in Figure 52. Brown trout density and standing crop substantially exceeded that observed for rainbow trout in the section and attained peaks in density and standing crop exceeding 800 fish per mile and 900 pounds per mile in 2000. Oswald (2000c) suggested that brown trout populations had flourished and increased markedly under ample flow regimes since 1995. Recent samples in 2001 and 2002, however, have exhibited brown trout population declines under declining flow regimes. These declines were similar to those observed for rainbow trout but delayed one year. Length analysis of the Greenhorn Section brown trout populations (Figure 53) indicated that numbers of older, larger fish which had maximized following ample flow regimes also declined markedly in 2001 and 2002. These declines in numbers of larger fish directly influenced the steep decline in biomass within the brown trout population. Recruitment of juvenile brown trout also benefitted from the ample flow regimes of the late 1990's and remained strong in 2001 as numbers of larger fish were reduced but declined markedly in 2002.

Despite large plants of yearling Arctic grayling in upstream Ruby River habitats since 1998, very few grayling have been captured during fall sampling in the Greenhorn Section. Numbers of Arctic grayling captured during two (mark and recapture) electrofishing passes through the 2.2 mile section between 1998 and 2002 averaged 4.8 fish per sample year and ranged between a high of 11 fish in 2000 and a low of zero fish in 2002. This data strongly suggests that the stocked arctic grayling have functioned in locating acceptable habitat and holding their position in the upper river as opposed to out migrating in search of acceptable habitat downstream or in Ruby Reservoir. Observations of grayling movements within the upper Ruby River made by Liermann (2001) over the 1998 - 1999 introduction period and data presented by Opitz (2000) and Oswald (2000c) also support this conclusion.

LOWER RUBY RIVER

Flow Regime

The lower Ruby River can be described as the reach between the Ruby Reservoir Dam and the mouth of the river at its confluence with the Beaverhead River near Twin Bridges, Montana. Oswald (2000c) described a limited tailwater reach downstream from the dam which is rapidly diminished due to a large number of major canals located between the dam and Alder, Montana. The remainder of the lower river is influenced by a few relatively minor tributaries and an inverted hydrograph similar to that described for the lower Beaverhead River. Flows in the lower Ruby River are thus controlled largely by flow releases or spring spillway overflow from Ruby Reservoir and accretions from irrigation return seepage to the valley floor. In 1994, Ruby Reservoir was completely drained resulting in a substantial fish kill in the reservoir and river tailwater (Oswald 2000a and 2000c). Mean overwinter flows in the tailwater of the dam since

1995 are presented in Figure 54 and compared with the Minimum Recommended Flow of 40 cfs for the reach. While ample storage in Ruby Reservoir between 1996 and 2000 resulted in overwinter flows that exceeded Minimum Flow Recommendations, flows in 2001 and 2002 dropped below the 40 cfs minimum. Low minimum flows in the tailwater reach generally reflect low flow conditions throughout the system although these flows can be manifest in late spring and summer in downstream reaches.

Passamari and Maloney Study Sections

The Passamari and Maloney Sections typify the limited tailwater environment of the lower Ruby River immediately downstream from the Ruby Reservoir dam. The study sections were established in 1994 and 1998 (Oswald 2000c) to monitor wild brown trout recovery in the aftermath of the 1994 fish kill and to monitor the affects of public fishing access in 1998. Brown trout population trends in the Passamari and Maloney Sections are depicted in Figure 55 for the 1994-2002 period of study. In the aftermath of the 1994 event, brown trout density was reduced to 257 Age I and older fish per mile representing a standing crop of only 227 pounds per mile. Steady increases in density and standing crop under relatively ample flow regimes resulted in full population recovery by 1999 and observed maxima in density and standing crop by 2000. The 2000 population estimate of 1,595 brown trout representing 1,508 pounds of biomass per mile was indicative of a productive tailwater environment and population expansion was not deterred by the acquisition of public fishing access in the reach in 1997. Reduced flow regimes in 2001 and 2002 were accompanied by declines in brown trout density and standing crop but both parameters remained at higher levels than those observed before the acquisition of public access. This was related to expanding numbers of 13 inch and larger fish (Figure 56) in the population which were not diminished by reduced flow regimes in 2001 and 2002. Peaks in brown trout standing crop were directly correlated with peaks in the abundance of older, larger fish in the population (Figure 57). Both standing crop and numbers of large fish peaked in 2000 following ample flow regimes and declined in 2001 and 2002 with reduced flow. Recruitment of juvenile brown trout (Figure 58) also increased markedly from 1997 through 2000 with ample flow and recovered numbers of large reproductive adults but declined abruptly in 2001 and 2002 with limited flow regimes. Similar to conditions observed in the tailwater reaches of the upper Beaverhead River under low flows, brown trout Condition Factor (Figure 59) declined in the Maloney Section over the 1999 - 2002 period. As was the case in the Beaverhead River study sections, the decline in Condition was manifest most severely in the older, larger fish in the population.

Silver Spring Study Section

The brown trout populations of the Silver Spring Section were last described by Oswald (2000c). Since that time, abundant and expanding brown trout populations (Figure 60) peaked in 2000 and declined similar to the Maloney Section with reduced flow regimes in 2001 and 2002. Recent peaks in density and standing crop did not match those observed over the 1989 - 1992 period and could be related to some affects of whirling disease as discussed by Opitz (1999) and Oswald (2000c). Recruitment of both Age I and Age II brown trout (Figure 61) improved over

the 1997 - 1999 period but declined, with receding flow regimes, over the 2000 - 2002 period although numbers of Age II fish were much improved over those observed during the 1993 - 1996 period. Densities of 13 inch and larger brown trout (Figure 62) also improved with improved recruitment (Oswald 2000c) and remained relatively high over the 2000 - 2002 period of study despite reduced stream flows. Numbers of 13 inch and larger fish, however, did not attain previous high levels observed in the early 1990's, prior to the discovery of whirling disease in the system. Densities of larger brown trout had improved over the 1995 - 2000 period with ample flow regimes but declined as flows were reduced in 2001 and 2002. These 16 inch and larger fish (Figure 63) largely comprise the Age V and older segment of the population. This decline in the density of older, larger fish was similar to that observed in the other Ruby River Study Sections as stream flows declined in the 1999 - 2002 period. Oswald (2000c) had noted that densities of 16 inch and larger fish appeared to flourish with reduced recruitment and population density.

Sailor Study Section

The Sailor Section has been sampled sporadically since 1979 and was last reported on by Oswald (2000c). A single sample was collected in 2000 as a portion of the Ruby River sampling during the current 2000 - 2002 reporting period. Brown trout population statistics are presented in Figure 64 for the 1979-2000 period of study. The 2000 sample exhibited a relatively high brown trout density and biomass for the section and represented a continuation of an improving population trend observed since 1995. Similarly, brown trout recruitment (Figure 65 and densities of 13 inch and larger fish (Figure 66) continued to improve through the 2000 sample season. Densities of older larger fish (Figure 67) declined from the 1998 sample but remained somewhat higher than those observed over the 1995 - 1997 period.

POINDEXTER SLOUGH

Section Three

The brown trout populations of Poindexter Slough were last described by Oswald (2000c). Recent trends in brown trout population density and standing crop are depicted in Figure 68 for the 1989-2002 period of study. Brown trout density peaked in 2000 following relatively ample flow regimes and improved recruitment (Figure 69) over the 1998 - 2000 period but declined with reduced flow and recruitment in the 2001 and 2002 samples. Poindexter Slough has traditionally supported the highest observed brown trout densities within the study area, however, most of this elevated density has been associated with highly successful recruitment of Age I fish. Oswald (2000c) noted that reduced recruitment in Poindexter Slough resulted in an improved mean standing crop relative to population density. This trend in biomass continued over the 2000 - 2002 period while population density (Figure 68) and recruitment (Figure 69) declined. While the recent recruitment of Age I fish declined in 2001 and 2002, it remained above most of the recruitment densities observed during the 1993 - 1997 period of study. Concomitant with improved standing crop, numbers of older larger fish continued an improving trend and remained at relatively high density since 1996. Numbers of 13 inch and larger fish (Figure 70) declined

somewhat in 2001 and 2002 after peaking in 2000 but remained abundant while numbers of 15 inch and larger fish (Figure 71) generally continued to improve through 2002.

BIG SHEEP CREEK

Shearing Pen Study Section

The trout populations of Big Sheep Creek have been studied sporadically over the 1980-2000 period. The Shearing Pen Section is located on lands administered by the BLM and was described by Oswald (2000c). The brown trout populations of the Shearing Pen Section are depicted in Figure 72 for the four years of sampling. The 1980 - 1996 samples revealed a trend toward increased population densities and standing crops which declined slightly in the 2000 sample while remaining relatively abundant. Recruitment of juvenile brown trout (Figure 73) appeared limited in all of the sample years but increased in a linear manner over the sample period. Numbers of 13 inch and larger fish (Figure 74) appeared to dominate the sampled populations and increased markedly in the 1996 sample followed by a slight decline in 2000. Numbers of 16 inch and larger brown trout appeared relatively static but improved slightly in 2000.

Population trends for rainbow trout in the Shearing Pen Section (Figure 75) had exhibited a declining trend over the 1980 - 1996 period of study but improved markedly in density in 2000. The population improvement in 2000 did not include biomass, however, which remained similar to levels observed in the 1980 and 1986 samples. Similarly, numbers of juvenile rainbow trout in the population (Figure 76) also declined substantially over the 1980 - 1996 period but did not improve substantially in the 2000 sample. Estimated densities of larger rainbow trout (Figure 77) recovered in the 2000 sample and represented densities approaching those observed in the peak year of 1986.

Canyon Study Section

The Canyon Section of Big Sheep Creek was first described and reported on by Oswald (2000c) for sporadic sampling over the 1982 - 1996 period. Brown trout densities and standing crops are presented in Figure 78 for the Canyon Section over the 1982-2000 period of study. Brown trout populations in the Canyon Section exceeded those observed in the Shearing Pen Section by a substantial amount but have exhibit similar trends through the 1996 sample. In contrast to observations in the Shearing Pen Section, however, brown trout density and standing crop increased markedly in the Canyon Section in the 2000 sample. The increased density was accompanied by markedly improved juvenile recruitment (Figure 79) which represented an improving trend. The improved 2000 brown trout standing crop in the Canyon Section was directly correlated with strong numbers of 13 inch and larger fish (Figure 80) in the population, however, numbers of 16 inch and larger fish remained relatively static at low density.

Rainbow trout densities and standing crops are presented in Figure 81 for the Canyon Section over the period of study. While 2000 brown trout populations had attained their observed

high for the study section, rainbow trout populations remained low, although improved over the 1996 sample. As was observed in the Shearing Pen Section, rainbow trout recruitment (Figure 82) remained very low and only slightly improved over 1987 and 1996 while improved numbers of older, larger fish (Figure 83) were largely responsible for the improvements in population density and standing crop. Oswald (2000c) discussed declining trends in the rainbow trout populations of the Canyon Section and noted that rainbow trout populations in the early 1980's exceeded brown trout densities and standing crops.

ODELL CREEK

Taft Study Section

Odell Creek is a tributary of Lower Red Rock Lake originating in the Centennial Mountains of southwest Montana. Boltz (1999) described spawning migrations of Arctic grayling, hybridized cutthroat trout, and native sucker species and Oswald (2000c) described resident trout populations and the genetic composition of the westslope cutthroat trout population of the lower reaches of the stream and its tributaries. The lower reaches of the stream and Lower Red Rock Lake are contained within the Red Rock Lakes National Wildlife Refuge. In 1994, the U.S. Fish and Wildlife Service Partners for Wildlife program entered into an agreement with a private property owner to mechanically improve channel stability and cutthroat trout habitat within a reach of Odell Creek located upstream from the Centennial Valley Road. The length of the Taft Section has not been provided by USFWS to date so population estimates were calculated for the entire section. Estimated numbers and standing crops of westslope cutthroat trout and brook trout are depicted in Figure 84 for the Taft Section in 1994 and 2000 samples. Westslope cutthroat trout density and standing crop far exceeded that of brook trout in the section immediately following habitat improvement in 1994. By the 2000 sample, however, brook trout numbers and standing crop had improved markedly over 1994 while the westslope cutthroat trout population had declined substantially. The 1994 westslope cutthroat density appeared relatively high when compared with other westslope cutthroat trout populations in the area while the brook trout population density appeared relatively low. The situation had reversed, however, by the 2000 sample. Length analysis within the two westslope cutthroat trout sample populations (Figure 85) revealed good balance for length and age distribution with declines apparent across all length groups between 1994 and 2000. Brook trout populations, however, increased largely due to ample recruitment of fish less than 8.0 inches in length and, particularly among fish less than 6 inches in length.

DISCUSSION

BEAVERHEAD RIVER

Upper River Study Sections

Brown trout populations in the upper tailwater reach of the Beaverhead River declined significantly in association with drought limited nonirrigation flow regimes which dominated the winter period since the 2001 Water Year. While minimum storage pools in Clark Canyon Reservoir rarely decline below minimum standards for fisheries maintenance (Oswald 1990, Oswald and Brammer 1993), expansion of these minimum pools often resulted in minimal flow delivery to the tailwater fisheries of the Beaverhead River during the winter months. Nonirrigation season flow regimes in the Beaverhead River failed to meet the Minimum Recommended Instream Flow (FWP 1989) of 200 cfs in twelve of the past twenty-two Water Years over the 1982 - 2003 period of record. Mean flow releases in nine of those twelve years failed to average even 25% of the recommended minimum. Brown trout population parameters which had flourished and maximized in 1998 or 1999 under the ample flow regimes of the 1996 - 2000 period included density, standing crop, numbers of older, larger fish, and Condition Factor in both the Hildreth and Pipe Organ Study Sections. Population parameters such as standing crop and numbers of larger, older fish (18, 20, or 22 inch and larger component) probably approached or exceeded carrying capacity (Oswald 2000c) as numbers of larger fish began to represent smaller percentages of the population indicating that growth and ultimate size were compromised at maximal standing crops and increasing density. Declines in brown trout standing crop, numbers of 18 inch or 20 inch and larger fish and brown trout Condition Factor over the 1999 - 2002 period were linear and similar to those observed in the 1988 - 1992 period (Oswald 1990, Oswald and Brammer 1993) although those declines were not as steep as or equal in magnitude to those of the prior episode. Oswald (2000c) described substantial losses of larger brown trout in association with severely limited overwinter flow regimes in the Hildreth and Pipe Organ Sections and overall brown trout population decline in the Pipe Organ Section. Oswald (2000b, 2002) noted declines of large brown trout in the Big Hole River over a prolonged period of drought reduced flow regimes and observed similar increases in numbers of large fish under ample flow conditions.

The data strongly suggest that limited nonirrigation flow releases into the Beaverhead River in order to maintain Clark Canyon Reservoir storage pools result in frequently encountered low flow regimes which limit brown trout populations. The data also substantially demonstrate that flow releases significantly exceeding or falling below the recommended minimum of 200 cfs maximize or minimize brown trout population parameters such as standing crop, numbers of older, larger fish in the population, and Condition Factor, especially that of the larger fish.

Rainbow trout density has continued a trend of slowly declining populations in association with expanded brown trout population density and standing crop. This decline has occurred while regulations restricting anglers to the harvest of only one rainbow trout have been in place since 1989. Oswald (2000c) suggested that factors other than angler harvest have been controlling rainbow trout abundance. While ample flow regimes of 1996 - 2000 resulted in an increasing standing crop for rainbow trout and numbers of larger fish, little improvement in stock density or

recruitment has been detected. Limited fall flow regimes and concern over adding stress to the rainbow and brown trout populations precluded the accurate sampling of the rainbow trout population in 2001 and 2002.

Brown trout populations in the Fish and Game Section did not experience similar declines to those observed for the upper tailwater study sections under drought influenced flows in the 1999 - 2002 period of study. Despite very low winter flow regimes, brown trout density, standing crop and numbers of older, larger fish in the population remained strong although Condition Factor exhibited declines similar to those observed upriver. The brown trout population response to low flow regimes was also in complete opposition to the response noted during the prior 1988 - 1991 drought episode which exhibited severe population decline. During the current drought event, emergency fishing closures were adopted in the falls of 2000 through 2002 as flow releases from Clark Canyon Dam were abruptly reduced. These angling closures were applied to the reach between the dam and Dillon, Montana and were intended to reduce overall stress, under drought flow conditions, on fish populations during the critical fall spawning period. These regulations also applied to the upper tailwater reach where it was noted that the rate and magnitude of population decline under the current drought episode has been less severe than that observed during the prior, 1988 - 1991 episode. In addition to the emergency drought closures, river rules intended to reduce concentrated angling pressure (Oswald 2000c, 2002) eliminated commercial guide float trips within the river reach which includes the Fish and Game Section. The data suggest that reduction in angling pressure could be mitigating the affects of drought on fish populations by reducing one source of stress under the chronic stress of extremely low flow regimes.

Oswald and Brammer (1993) suggested that the Low Flow Section was better adapted to lower flow regimes through the production of higher densities of smaller fish than upstream study sections which normally experience more abundant flow regime and maintain larger channel cross section. This was apparent in comparative brown trout population responses through 1993. Since 1994, however, brown trout populations declined with reduced recruitment and remained relatively low in 1998 and 2000 despite ample flow regimes. Oswald (2000c) noted that trout populations in the Low Flow Section declined following a similar decline in population associated with the discovery of whirling disease in Poindexter Slough. The Low Flow Section is located downstream from the mouth of Poindexter Slough which has since exhibited a full recovery in brown trout recruitment. It was speculated that whirling disease had influenced brown trout recruitment in Poindexter Slough and downstream in the Low Flow Section. Opitz (1999), however, felt that population declines in Poindexter Slough were within the range of normal brown trout population dynamics and did not attribute the low populations to whirling disease.

<u>Lower River Study Sections</u>

Oswald (2000c) noted that brown trout populations in the lower Beaverhead River have remained at low density since the 1970's with very little, if any, significant change. Oswald and Brammer (1993) listed habitat problems characteristic of the lower river including altered flow regime, heavy bedload transport associated with an inverted hydrograph, channel atrophy, high summer temperatures, and bank instability associated with poor woody riparian vegetative

development. While summer flow regimes in the late 1990's were capable of matching or exceeding the recommended minimum flow of 200 cfs, recent flow regimes since 2000 have declined far below the recommended minimum. This chronic low summer flow condition has been the dominant flow regime in nine of the past fifteen Water Years. Recent low flow conditions have resulted in declining densities, standing crops and juvenile recruitment although density has declined more rapidly than standing crop as relatively high percentages of larger fish marked some of the samples. The recently initiated Silver Bow Study Section exhibited lower population densities and standing crops than those observed in upstream sections or the Twin Bridges Section below the mouth of the Ruby River. This suggests that differential flow regimes also affect brown trout populations within the chronically dewatered lower river reach. The improved brown trout densities, standing crop, and recruitment in the 2002 Mule Shoe sample suggests that the reach might have experienced more favorable flow regimes than the remainder of the lower river reach and could have functioned as a refuge. This was further evidenced by the favorable response of mountain whitefish and white sucker populations as well as introduced Arctic grayling in the Mule Shoe Section in 2002. This flow refuge potential should be further investigated in future samples in the section under low summer flow regimes.

Due to low brown trout density, favorable length of river reach available, and active alluvial processes, the lower Beaverhead River was selected by MFWP as an Arctic grayling recovery area and received its first plants of overwintered grayling in 1999. Preliminary observations suggested that the grayling have distributed throughout the reach and a fall migration in a downstream direction was triggered by the rising limb of the inverted hydrograph (Oswald 2000c). Subsequent grayling plants over the 2000 - 2002 period fared poorly under low flow conditions. Low survival of summer plants to their first fall in the river and poor overwinter survival to Age II have lead to a temporary suspension of Arctic grayling introduction efforts until more favorable flow regimes are encountered. Other factors suspected of influencing the recent grayling introductions have been insufficient stock density, small size of fish in the plants, and predation by large brown trout. The predative factor could also be enhanced under low flow regimes which have typified the reach since 2000.

Additional sampling of native species was initiated in the lower river reach in 2001 with fall samples of white and longnose sucker and spring sampling of mountain whitefish. Preliminary results suggest that mountain whitefish can attain densities and standing crops equaling or exceeding those observed for brown trout within the reach. Whitefish density increased in a downstream direction while standing crop was higher upstream due to a preponderance of larger fish at lower density. Preliminary data suggest that whitefish growth may have been reduced in the Silver Bow Section compared with the two upriver study sections.

Numbers of white and long nose sucker appeared somewhat volatile throughout the lower river reach with disparate results obvious between study section and year. Numbers of both white and long nose sucker in the Anderson Study Section were too low to provide a valid population estimate in either 2001 or 2002 and populations of both species were dominated by juvenile fish. White sucker populations in the Mule Shoe and Silver Bow Sections were relatively abundant and appeared to exhibit successful recruitment in 2002 although the overall population declined between 2001 and 2002 in the Silver Bow Section due to losses in older fish. The same increase or population abundance exhibited in the 2002 Mule Shoe Section sample by brown trout, Arctic

grayling and mountain whitefish was noted for white sucker. Numbers of longnose sucker in the Mule Shoe and Silver Bow Sections were very low compared with other species and populations were dominated by older, larger fish.

UPPER RUBY RIVER

Oswald (2000c) noted that populations of rainbow x cutthroat hybrids, rainbow trout, and brown trout had all recovered from drought influenced flow regimes of the 1985-1994 period and flourished as ample flow regimes dominated the 1995 - 1999 period in the upper Ruby River. Recovery in terms of highs in density, standing crop, recruitment and condition factor were all observed in the Three Forks and Greenhorn Sections. These population parameters have all entered into declining trends, however, as summer flow regimes have declined below recommended instream flows over the 2000 - 2002 period of study. Declines in standing crop, numbers of larger fish in the population and Condition Factor for the rainbow X cutthroat trout hybrid swarm of the Three Forks Section mimic those observed in larger mainstem rivers like the Big Hole (Oswald 2002) or Beaverhead River (Oswald 2000c) despite a lack of any major irrigation diversion or flow manipulation. Major declines in the rainbow trout population of the Greenhorn Section, however, have also been accompanied by a virtual lack of recruitment success since 1999. Further study will be required to determine if other factors, such as whirling disease, are affecting rainbow trout recruitment in the section.

Arctic grayling reintroduction efforts in the upper Ruby River have met with limited success to date. While stocked populations of grayling have demonstrated an affinity for the fluvial environment of the Ruby, maintained high population density throughout the stocked reach (Opitz 2000), and exhibited an ability to migrate within the system without drifting into Ruby Reservoir (Liermann 2001), winter survival has appeared to be a significant limiting factor. Perhaps the most important successful component of the reintroduction effort has been the documentation of successful reproduction over the 2000 - 2002 period (Magee 2002). Questions still remain, however, as to whether the stock density of grayling surviving to reproductive adulthood can represent sufficient reproductive density to provide sufficient natural recruitment into a persistent population. Natural carrying capacity of habitats, particularly at low flow regimes, must certainly limit the rate at which yearling grayling can be stocked. Surprisingly, the artificial placement of a large standing crop of grayling into the apparently limited environment of the Three Forks Section did not result in deleterious affects on the wild rainbow x cutthroat hybrid population which occupied the reach upon the initiation of reintroduction efforts (Oswald 2000c). Oswald further noted, however, that the density and standing crop of these wild fish remained high in spite of the high density grayling population and their mean condition factor remained high concomitant with ample habitat niche at high flow. If overwinter mortality and productive or habitat niche limits on stock density of yearling grayling prove to be insurmountable limiting factors, other alternatives such as fertilized eggs in remote site incubators might have to be employed to achieve viable stock densities of reproductive adults.

LOWER RUBY RIVER

The complete dewatering of the Ruby Reservoir in 1994 resulted in a substantial fish kill and heavy losses in the wild brown trout population of the river below the dam. Oswald (2000a and 2000c) described rainbow trout population recovery after 1995 in the Ruby Reservoir and full recovery of wild brown trout populations in the productive tailwater environment of the river. Actions taken via the establishment of a Governor's Ruby River Task Force in 1994 and 1995 coupled with ample storage in Ruby Reservoir and ample flow regimes in the Ruby River resulted in maximum brown trout densities and standing crops by the 2000 sample. Brown trout condition factor, juvenile recruitment, and densities of 18 inch and larger fish also peaked in 1999 or 2000 in the Maloney Section. These major brown trout population parameters peaked with abundant stream flow despite the acquisition of public fishing access through the Maloney Section Reach in 1997. Oswald (2000c) discussed concern over unrestricted public access to reaches of the lower Ruby River and the implementation of special restrictive regulations in anticipation of negative affects of angler driven mortality. The data strongly suggest that brown trout populations, including densities of large fish, were unaffected by angling pressure under the prevailing regulations. Moreover, comparative data with other lower Ruby River Study Sections strongly suggested that brown trout populations were unaffected by angling prior to the inception of the special regulations (Oswald 2000c). In an evaluation of special restrictive regulations on the Big Hole River, Oswald (Vincent et al. 1989) suggested that the restrictions had little discernible affect after eight years of implementation and further suggested (Oswald 2000b) that the prevailing voluntary angler practice of catch and release was adequate to maintain brown trout mortality within natural population rates. Brown trout population declines in the Maloney Section over the 2001 - 2002 period were directly attributable to diminished flow regimes and included reduced density, standing crop, recruitment, condition factor, and numbers of 18 inch and larger fish. These responses were similar to those observed in the upper Beaverhead River tailwater study sections under reduced flow regimes. Due to strong juvenile recruitment in 1999 and 2000, numbers of 13 inch and larger fish continued to increase and attained an observed peak for the study section despite the reduced flow regimes. Strong numbers of these younger fish should provide for rapid brown trout population recovery when minimum flow requirements for the section are met.

Dramatic decreases in brown trout populations were noted in the Silver Spring Section over the 1993-1996 period and observed, in a more limited manner, in the Sailor Section downstream. The 1995 discovery of whirling disease triggered companion graduate research on the affects of the disease on brown trout in the lower Ruby River and Poindexter Slough. While the study could not directly confirm that whirling disease was the causative vector of declining recruitment in both streams, Opitz (1999) suggested that the disease may have been the cause of the decline in the lower Ruby River. Brown trout recruitment of Age I and Age II cohorts improved markedly in the Ruby River in the 1997-1999 samples with improving streamflow and declined as flow regimes receded over the 2000 - 2002 period. Other typical brown trout population parameters such as density, standing crop, and numbers of older, larger fish increased with improved flows over the 1996 - 1999 period and declined with reduced flow regimes similar to the population responses noted in the Maloney Section. Brown trout generally demonstrate a

resistance to whirling disease although populations can be affected under favorable conditions for *Myxobolus cerebralis* (Walker and Nehring 1995). It is possible, however, that more than 100 years of wild brown trout recruitment in the absence of the disease in Montana may have resulted in a population composed of individuals naive to the disease and a loss of some of this resistance. Conversely, many, if not most, of the juveniles surviving to adulthood may have retained this natural resistance to the disease and subsequently passed it on to their progeny. This possibility was also discussed by Opitz (1999) in explanation of improving recruitment following the four year period of decline prior to his study. It is interesting to note that four years is generally the period of time required to attain full reproductive maturity for most brown trout in southwest Montana. The most recent data suggest that flow regimes, rather than whirling disease, have had the most direct impact on brown trout population parameters, including recruitment, in the Silver Spring Section. Limited data from the Sailor Section indicate a similar population response. Similar to the observed situation in the Maloney Section, the proximity of public angling access to the Silver Spring Section has had no discernible affect on brown trout populations while exclusive angling access and numerous habitat improvement projects have not resulted in superior brown trout populations in the Sailor Section.

POINDEXTER SLOUGH

Poindexter Slough has generally supported extremely abundant wild brown trout populations exceeding any other water in the project area in lineal density. Most of the high population densities in Poindexter Slough have been associated with strong annual recruitment of Age I fish (Oswald 2000c). Major declines in recruitment over the 1993 - 1997 period concomitant with the discovery of whirling disease in 1995 (Oswald 2000c) elevated concern over declining brown trout density. Poindexter Slough provides excellent habitat for *Tubifex tubifex*, an intermediate host for *Myxobolus cerebralis*, and may provide for "hot spots" for the disease (Opitz 1999). Such hot spots have been identified in the upper Colorado River (Walker and Nehring 1995) in association with declines in brown trout recruitment. As was the case in the lower Ruby River, recovery in brown trout recruitment in Poindexter Slough closely mimicked the length of time required for reproductive maturation of cohorts recruited in the aftermath of the severe population declines. While slight recent brown trout density declines have been observed in Poindexter Slough, brown trout standing crop has remained relatively stable. This was due to population compensation in the form of increased numbers of larger fish at slightly reduced population density. This suggested that growth rates and ultimate size for individual fish in the population were improved by the decreased density and further suggested that Poindexter Slough brown trout standing crops have been maintained at, or very close to, carrying capacity. Similar observations were made for larger fish as density declined in the lower Ruby River while brown trout ultimate size has been reduced in the upper Beaverhead River under burgeoning population density and standing crop (Oswald 2000c). Although Poindexter Slough has been impacted by the recent drought and somewhat reduced flows, it is difficult to attribute the slight declines in population density to inadequate flow in lieu of a similar response among the other normally

affected population parameters. It is probable that the spring creek habitat of Poindexter Slough is capable of maintaing base flow sufficient to meet habitat needs although no flow measuring gage site is located on the stream.

BIG SHEEP CREEK

Big Sheep has long been recognized as a popular tributary sport fishery for wild brown and rainbow trout of relatively large size and strong abundance. The stream incorporates features of a high gradient mountain tributary and a productive spring creek due to its limestone batholith and abundant spring flow accretions. Trout population sampling in Big Sheep Creek has been sporadic over the years but several observations can be made from the data. Oswald (2000c) observed that differences could be discerned among different habitat types represented in the sampling but little difference could be discerned between sections under public land management and exclusive private land management. Moreover, the data suggested that habitat improvement strategies employed by private landowners had not resulted in any significant differences in trout populations from reaches under public land management. The presence of whirling disease was confirmed in rainbow and brown trout collected from Big Sheep Creek in 1996 with the Shearing Pen and Canyon Section population samples exhibiting declining rainbow trout populations with reduced recruitment while brown trout populations and recruitment had flourished (Oswald 2000c). While the 2000 samples in both Study Sections exhibited improvement in rainbow trout density, little improvement could be discerned in recruitment despite habitat conditions which had obviously favored brown trout density and recruitment. Data suggest that whirling disease could be responsible for the rainbow trout decline, however, additional sampling will be required to confirm that.

WESTSLOPE CUTTHROAT TROUT RESTORATION PROJECTS

ODELL CREEK

Concern over the persistence of native westslope cutthroat trout stocks has led to various experimental habitat improvement projects designed to insure perpetuation of the species. Habitat improvement projects have often revolved around livestock grazing management strategies and riparian fence construction, mine reclamation projects, altered timber harvest strategies, or improved road management techniques. Some projects have involved construction of barriers and incorporated removal of nonnative species of salmonids to prevent hybridization or reduce competition. Other endeavors, such as the Odell and Stone Creek projects have involved major reconstruction of unstable stream channels and stream banks in addition to the incorporation of strategies mentioned above (Oswald 1999 and 2000c).

The Odell Creek project incorporated the 1994 sample immediately following construction efforts in the experimental reach. The sample demonstrated a relatively abundant westslope cutthroat trout population with limited encroachment by the introduced brook trout. The 2000 sample revealed some unexpected results as the original relationship between westslope cutthroat trout and brook trout was essential reversed. The data suggest that habitat improvement

techniques might have resulted in a niche which favored the brook trout over the native cutthroat. The westslope cutthroat population appeared to be reduced through all length and age classes while the majority of the brook trout abundance appeared to be associated with two large recruitment cohorts. It is thus possible, that the 2000 sample was not indicative of a habitat shift in favor of the brook trout but, rather, a temporary shift in climatic or flow conditions which favored brook trout recruitment as the cutthroat trout populations was reduced. More research should be directed to further determine if the population shift toward brook trout was a permanent change in species composition resulting from mechanical habitat alteration. In the interim, the data should serve as a cautionary warning to agencies interested in habitat restoration endeavors in systems which support nonnative salmonids in sympatry with populations of native westslope cutthroat trout.

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Report Prepared By: Richard A. Oswald, MFWP, Region 3, Bozeman June 2000

All Work Included in this Report in Conjunction with Federal Aid in Fish and Wildlife Restoration Acts:
Project Numbers: F-78-R-6, F-113-R-1, and F-113-R-2

Montana Fish, Wildlife & Parks Project Number 3320

APPENDIX OF FIGURES

Figure 1. End of irrigation season (fall) storage in Clark Canyon Reservoir, 1982 - 2002.

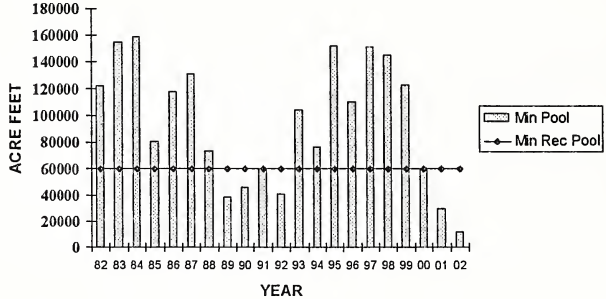

Figure 2. Mean nonirrigation season (October through March) flow release into the Beaverhead River from Clark Canyon Dam over the 1982 - 1992 and 1995 - 2003 Water Years.

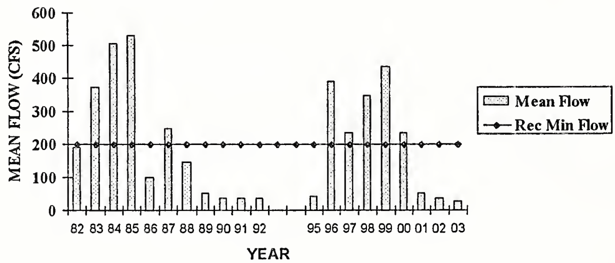

Figure 3. Estimated spring density and standing crop of brown trout in the Hildreth Section of the Beaverhead River, 1986 - 2002.

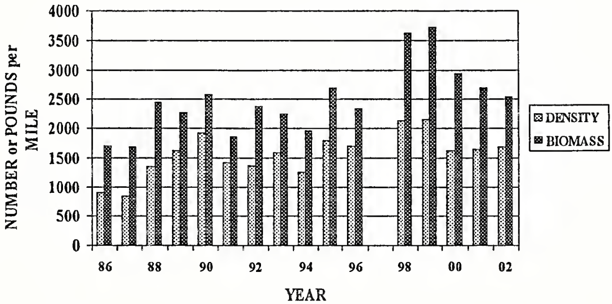

Figure 4. Estimated spring density of 18 inch and larger brown trout in the Hildreth Section of the Beaverhead River, 1986 - 2002.

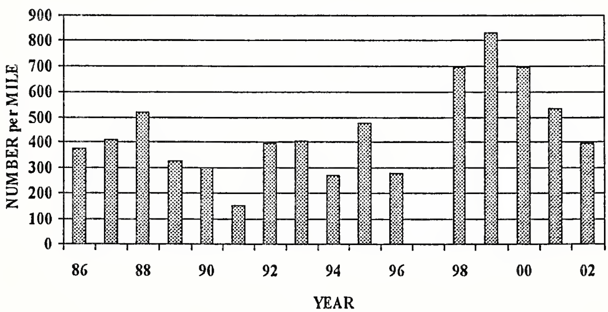

Figure 5. Estimated spring density of 20 inch and larger brown trout in the Hildreth Section of the Beaverhead River, 1986 - 2002.

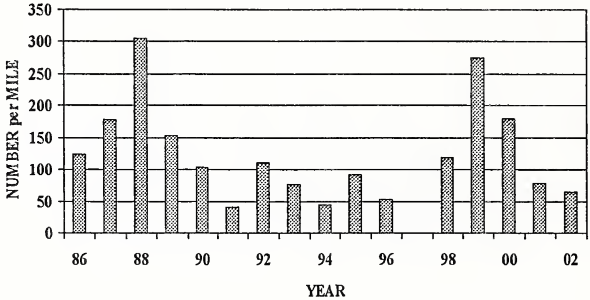

Figure 6. Estimated spring density of 22 inch and larger brown trout in the Hildreth Section of the Beaverhead River, 1986 - 2002.

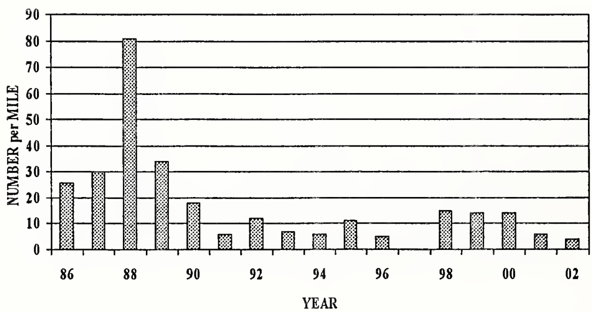

Figure 7. Mean spring Condition Factor (K) for Age II and older brown trout and the 18 inch and 20 inch and larger length groups of brown trout collected in the Hildreth Section of the Beaverhead River, 1999 - 2002.

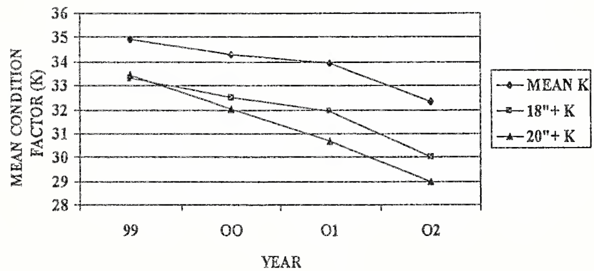

Figure 8. Estimated fall density and standing crop of Age I and older rainbow trout in the Hildreth Section of the Beaverhead River 1986 - 2000.

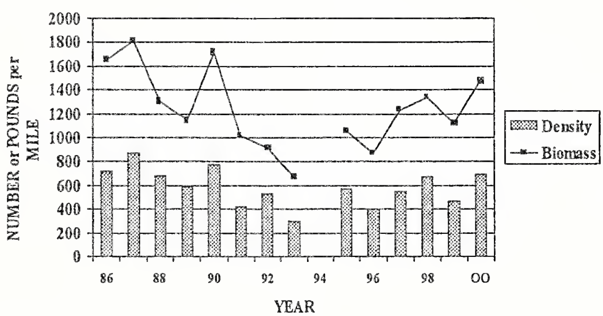

Figure 9. Estimated fall density of 18 inch and larger and 20 inch and larger rainbow trout in the Hildreth Section of the Beaverhead River, 1986 - 2000.

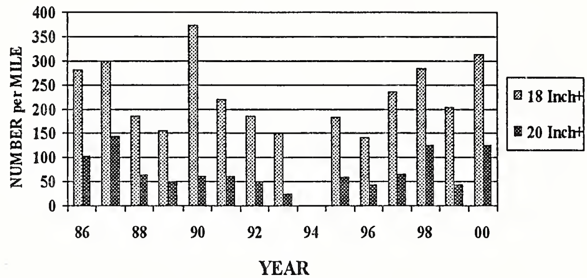

Figure 10. Estimated spring density and standing crop of Age II and older brown trout in the Pipe Organ Section of the Beaverhead River, 1986 - 2002.

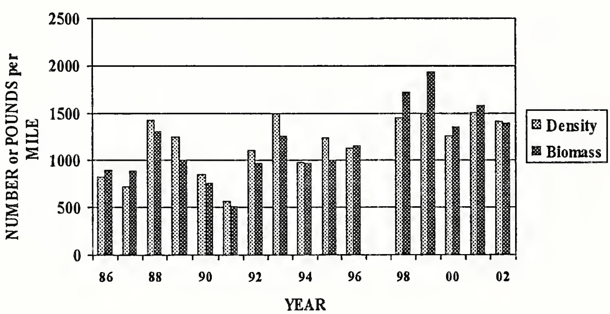

Figure 11. Estimated spring density of 18 inch and larger brown trout in the Pipe Organ Section of the Beaverhead River, 1986 - 2002.

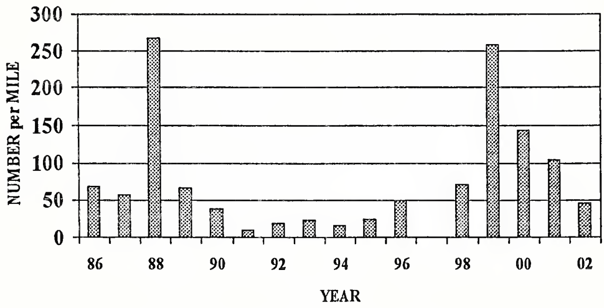

Figure 12. Mean spring Condition Factor (K) for Age II and older brown trout and 18 inch and larger brown trout in the Pipe Organ Section of the Beaverhead River, 1999 -2002.

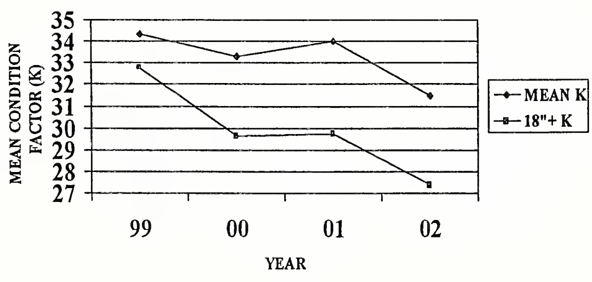

Figure 13. Estimated spring density and standing crop of Age II and older brown trout in the Fish and Game Section of the Beaverhead River, 1988 - 2002.

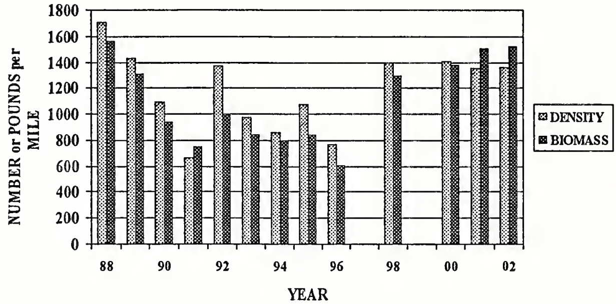

Figure 14. Estimated spring densities, by length group, of Age II and older brown trout in the Fish and Game Section of the Beaverhead River, 1988 - 2002.

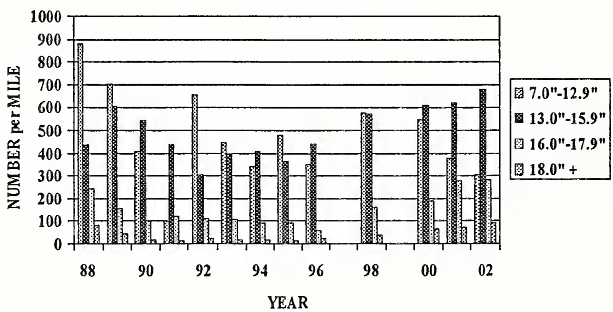

Figure 15. Mean spring Condition Factor (K) for Age II and older brown trout and 18 inch and larger brown trout in the Fish and Game Section of the Beaverhead River 1998 - 2002.

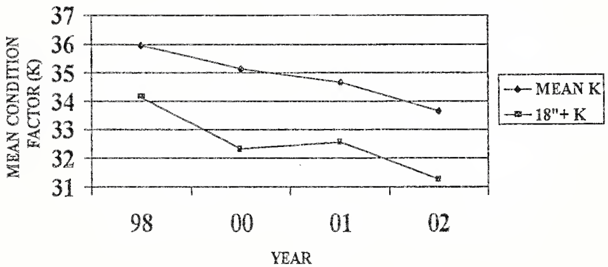

Figure 16. Estimated spring density and standing crop of Age II and older brown trout in the Low Flow Section of the Beaverhead River, 1987 - 2000.

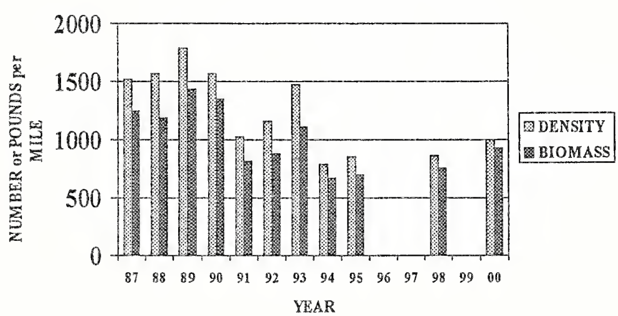

Figure 17. Estimated spring densities, by length group, of Age II and older brown trout in the Low Flow Section of the Beaverhead River, 1987 - 2000.

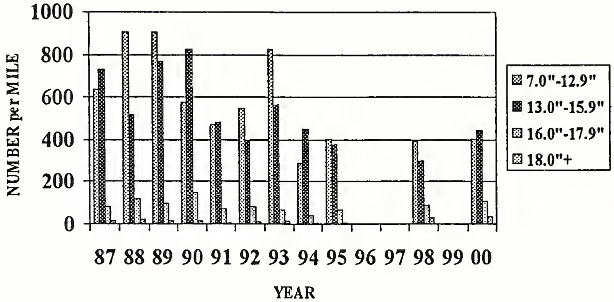

Figure 18. Mean July and August flows (cfs) and Minimum Recommended Flow (WETP Method) for the lower Beaverhead River measured at the USGS Twin Bridges Gage, 1988 - 2002.

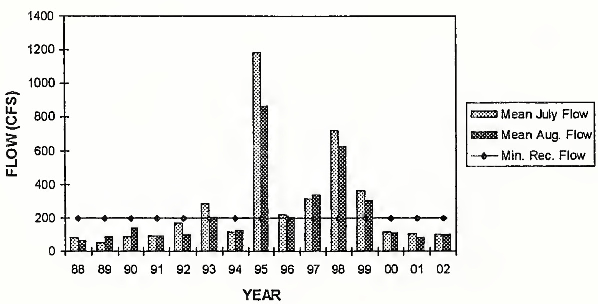

Figure 19. Estimated spring density and standing crop of Age II and older brown trout in the Anderson Section of the Beaverhead River, 1991 - 2002.

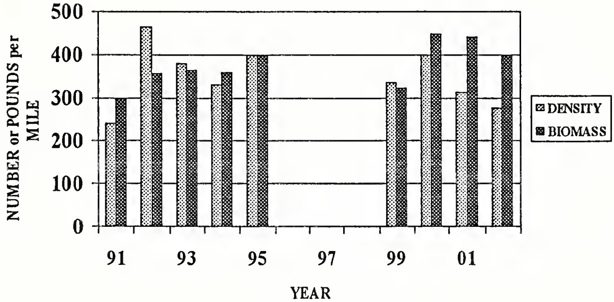

Figure 20. Estimated spring densities, by length group, of Age II and older brown trout in the Anderson Section of the Beaverhead River, 1991 - 2002.

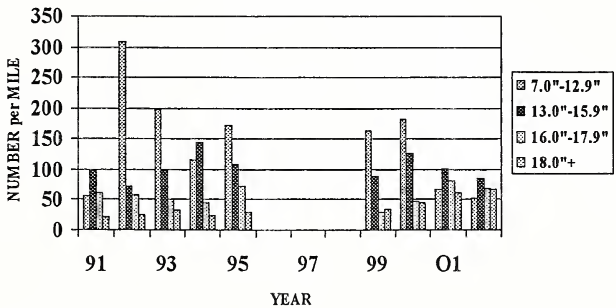

Figure 21. Spring and fall numbers of introduced Arctic Grayling captured during two electrofishing passes (mark and recapture) through the Anderson Lane Study Section (3.10 miles) of the Beaverhead River 1999 - 2002.

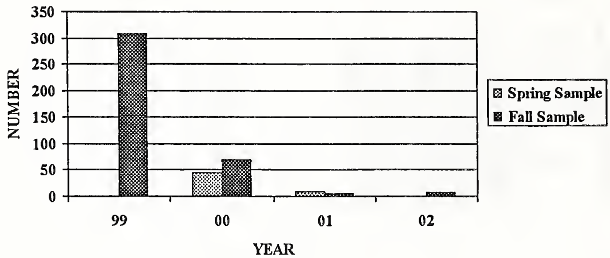

Figure 22. Estimated spring density and standing crop of Age II and older mountain whitefish in the Anderson Study Section of the Beaverhead River, 2002.

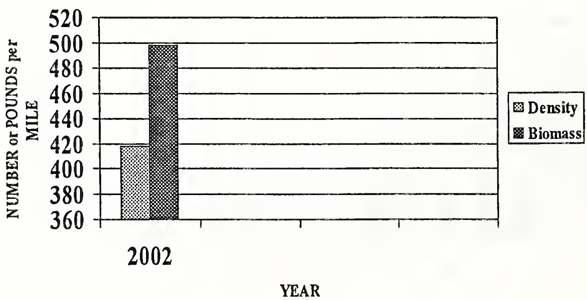

Figure 23. Length - frequency distribution of Age II and older mountain whitefish collected in the Anderson Study Section of the Beaverhead River, spring 2002 (N=597).

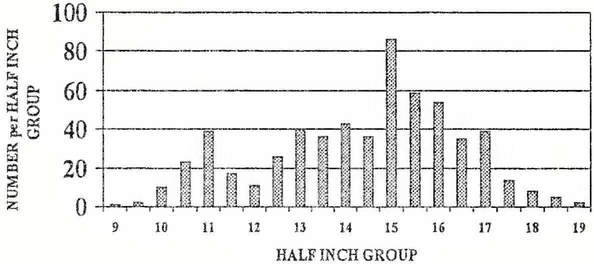

Figure 24. Number of white and longnose sucker captured by electrofishing in mark and recapture passes through the Anderson Study Section of the Beaverhead River in fall samples, 2001 and 2002.

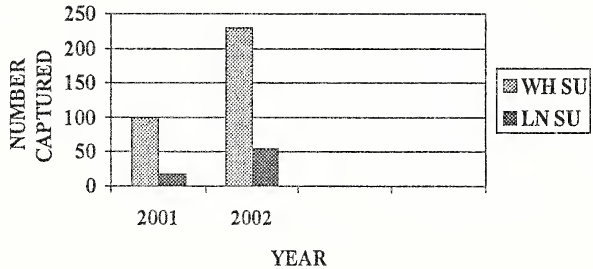

Figure 25. Length - frequency distribution of Age I and older white suckers collected in fall samples from the Anderson Study Section of the Beaverhead River, 2001 (N=101) and 2002 (N=234).

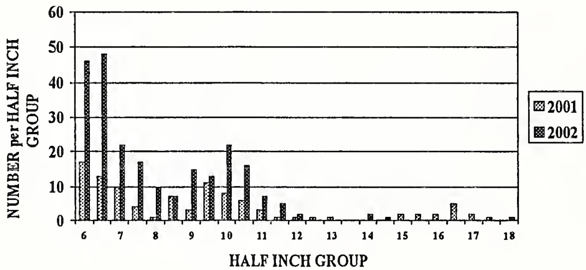

Figure 26. Length - frequency distribution of Age I and older longnose suckers collected in fall samples from the Anderson Study Section of the Beaverhead River, 2001 (N=17) and 2002 (N=55).

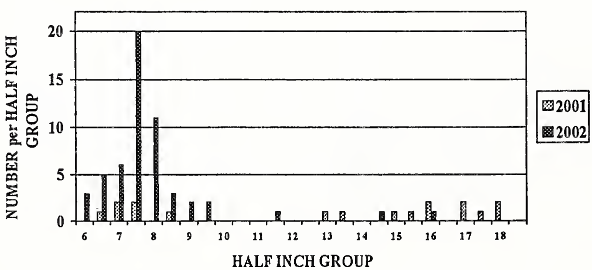

Figure 27. Estimated spring density and standing crop of Age II and older brown trout in the Mule Shoe Section of the Beaverhead River, 1990 - 2002.

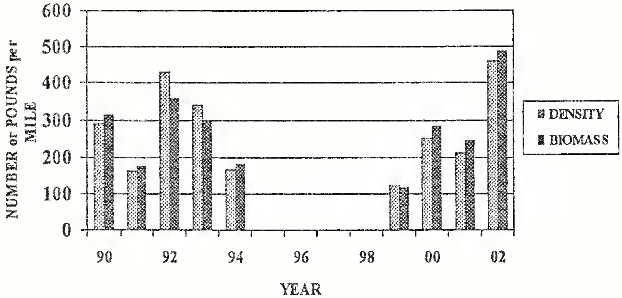

Figure 28. Estimated spring densities, by length group, of Age II and older brown trout in the Mule Shoe Section of the Beaverhead River, 1990 - 2002.

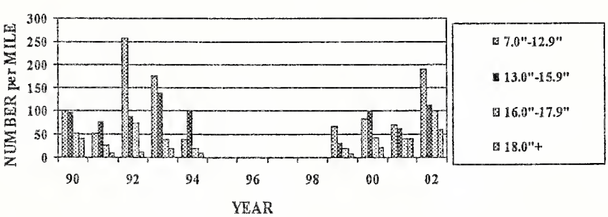

Figure 29. Spring and fall numbers of introduced Arctic Grayling captured during two electrofishing passes (mark and recapture) through the Mule Shoe Study Section (3.14 miles) of the Beaverhead River; 1999 - 2002.

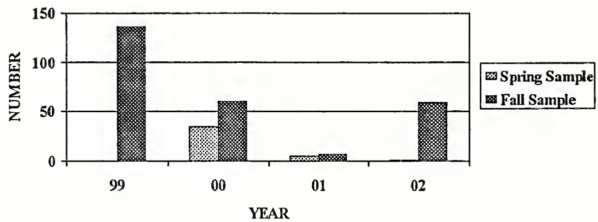

Figure 30. Estimated spring density and standing crop of mountain whitefish in the Mule Shoe Study Section of the Beaverhead River, 2002.

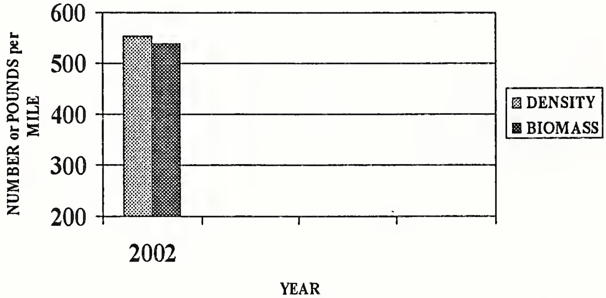

Figure 31. Length - frequency distribution of Age II and older mountain whitefish collected in spring samples from the Mule Shoe Study Section of the Beaverhead River, 2002 (N=501).

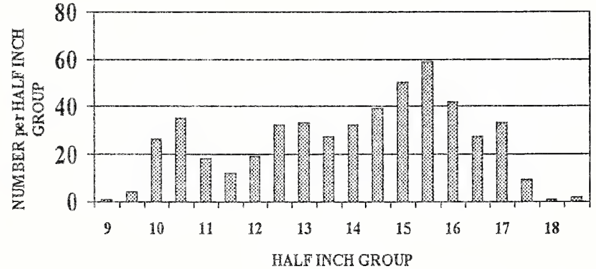

Figure 32. Estimated fall density and standing crop of Age I and older white sucker in the Mule Shoe Study Section of the Beaverhead River, 2001 - 2002.

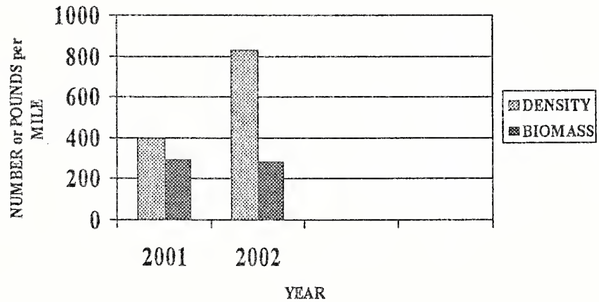

Figure 33. Length - frequency distribution of Age I and older white sucker collected in fall samples from the Mule Shoe Study Section of the Beaverhead River, 2001 (N=189) and 2002 (N=277)

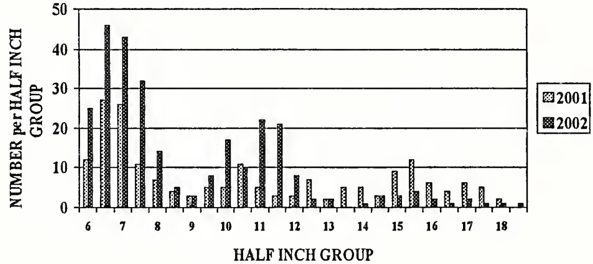

Figure 34. Estimated fall density and standing crop of Age I and older longnose sucker in the Mule Shoe Study Section of the Beaverhead River, 2001 - 2002.

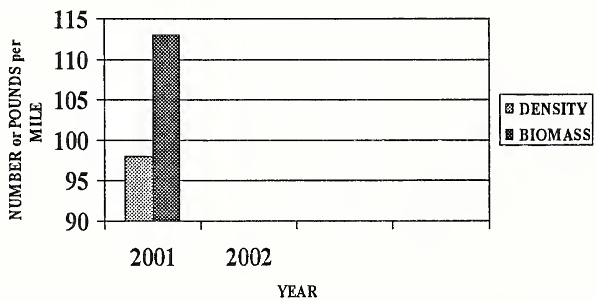

Figure 35. Length - frequency distribution of Age I and older longnose sucker from fall samples collected in the Mule Shoe Study Section of the Beaverhead River; 2001 (N=71) and 2002 (N=25).

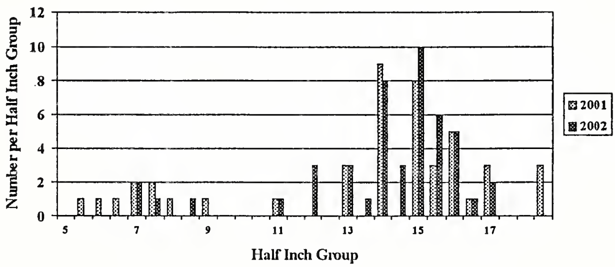

Figure 36. Estimated spring density and standing crop of Age II and older brown trout in the Silver Bow Section of the Beaverhead River, 2001 - 2002.

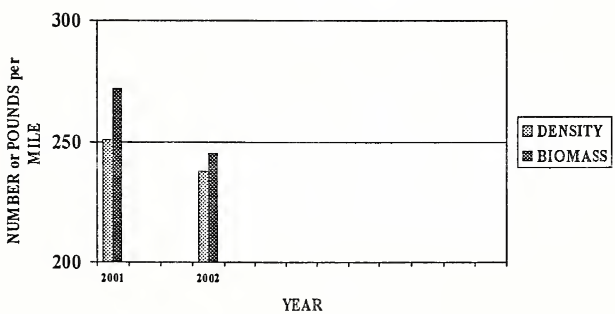

Figure 37. Estimated spring densities, by length group, of Age II and older brown trout in the Silver Bow Section of the Beaverhead River, 2001 - 2002.

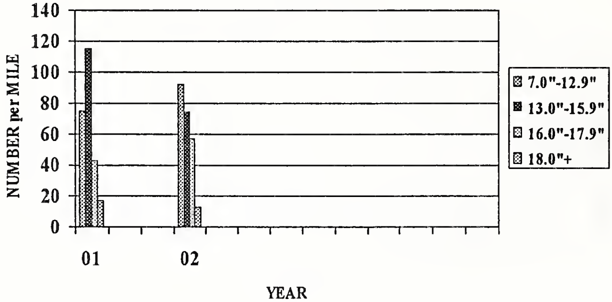

Figure 38. Spring and fall numbers of introduced Arctic Grayling captured during two electrofishing passes (mark and recapture) through the Silver Bow Study Section (2.50 miles) of the Beaverhead River; 2000 - 2002.

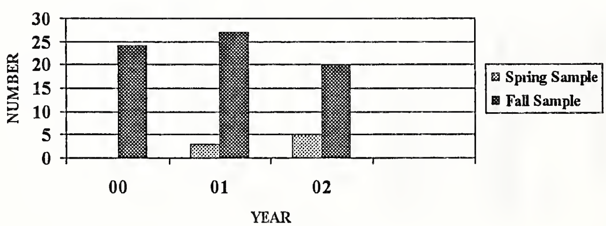

Figure 39. Estimated spring density and standing crop of Age II and older mountain whitefish in the Silverbow Study Section of the Beaverhead River, 2002.

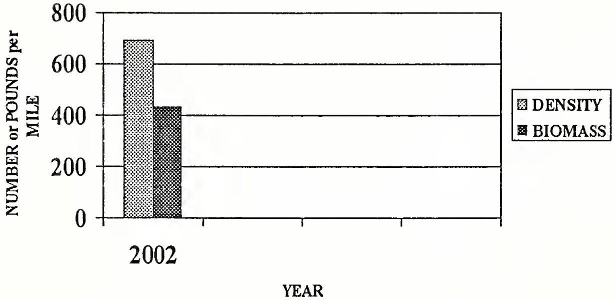

Figure 40. Length - frequency distribution of Age II and older mountain whitefish collected in spring samples from the Silverbow Study Section of the Beaverhead River, 2002 (N=527)

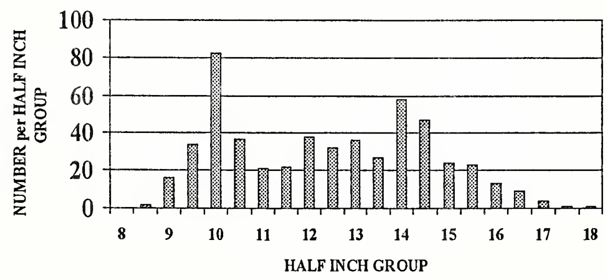

Figure 41. Estimated fall density and standing crop of Age I and older white sucker in the Silverbow Study Section of the Beaverhead River, 2001 - 2002.

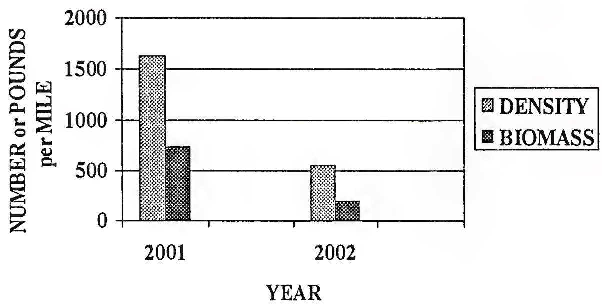

Figure 42. Length - frequency distribution of Age I and older white sucker collected in the Silverbow Study Section of the Beaverhead River, 2001 (N=404) and 2002 (N=220).

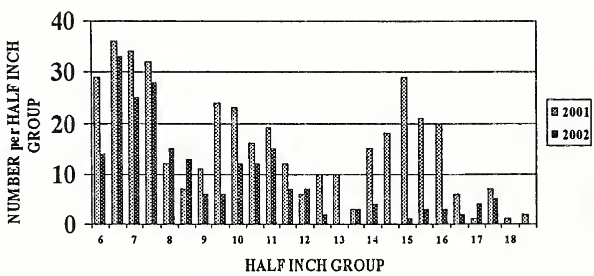

Figure 43. Estimated fall density and standing crop of Age I and older longnose sucker in the Silverbow Study Section of the Beaverhead River, 2001 - 2002.

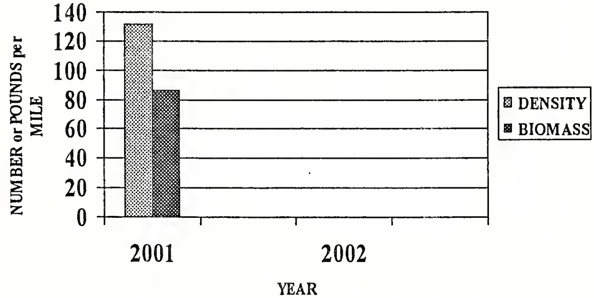

Figure 44. Length - frequency distribution of Age I and older longnose sucker collected in fall samples from the Silverbow Study Section of the Beaverhead River, 2001 (N=91) and 2002 (N=8).

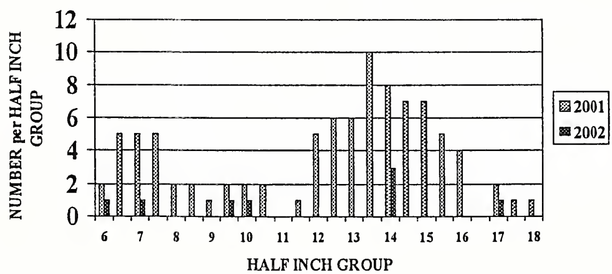

Figure 45. Mean August Flow (cfs) compared with the Minimum Recommended Flow (WETP Method) for the Upper Ruby River Measured at the USGS Gage Site 1986 - 2002.

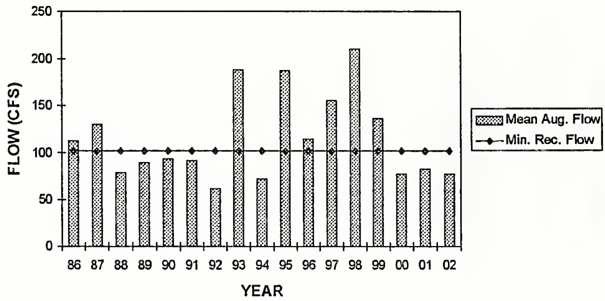

Figure 46. Estimated fall density and standing crop of Age I and older rainbow x cutthroat hybrid trout in the Three Forks Section of the Ruby River, 1987 - 2002.

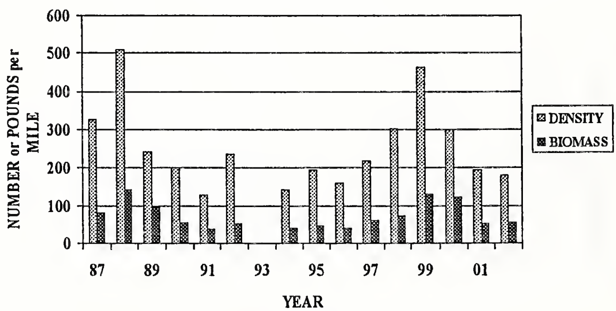

Figure 47. Estimated fall density, by length group, for Age I and older rainbow x cutthroat hybrid trout in the Three Forks Section of the Ruby River, 1987 - 2002.

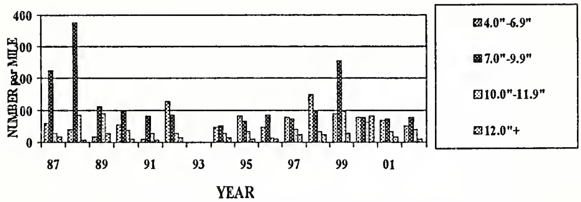

Figure 48. Mean fall Condition Factor (K) for Age I and older rainbow x cutthroat hybrid trout in the Three Forks Section of the Ruby River, 1987 - 2002.

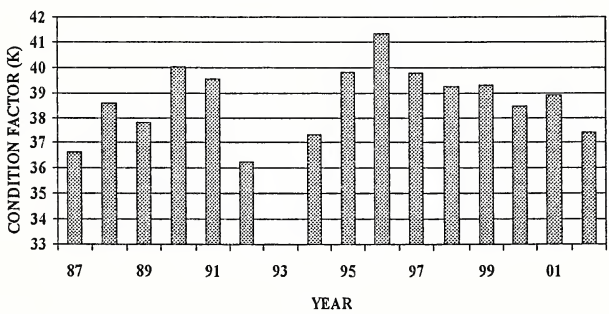

Figure 49. Estimated fall density and standing crop for Age I and older Arctic grayling in the Three Forks Section of the Ruby River 1998 - 2002.

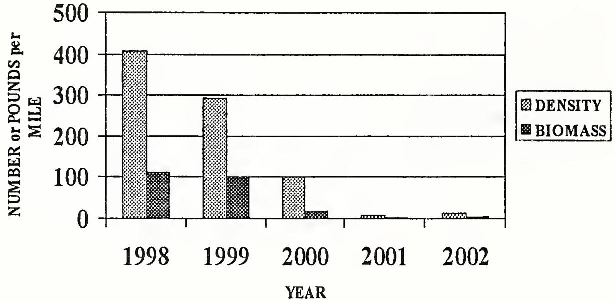

Figure 50. Estimated fall density and standing crop of Age I and older rainbow trout in the Greenhorn Section of the Ruby River, 1990 - 2002.

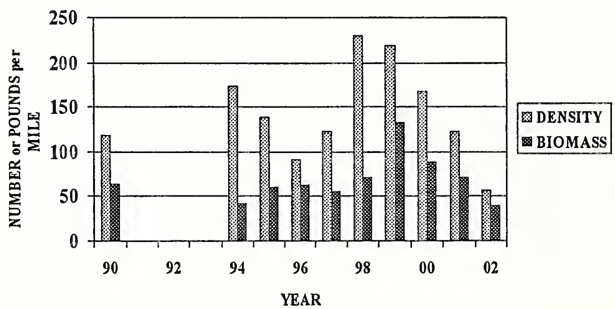

Figure 51. Estimated fall densities, by length group, of Age I and older rainbow trout in the Greenhorn Section of the Ruby River 1990 -2002.

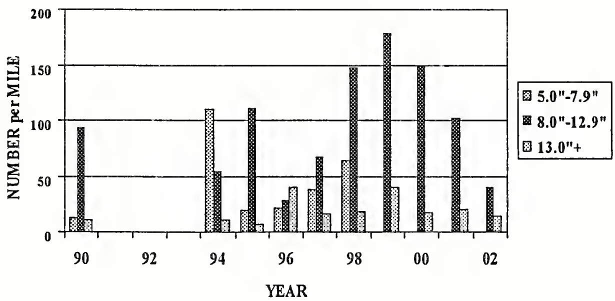

Figure 52. Estimated fall density and standing crop of Age I and older brown trout in the Greenhorn Section of the Ruby River, 1990 - 2002.

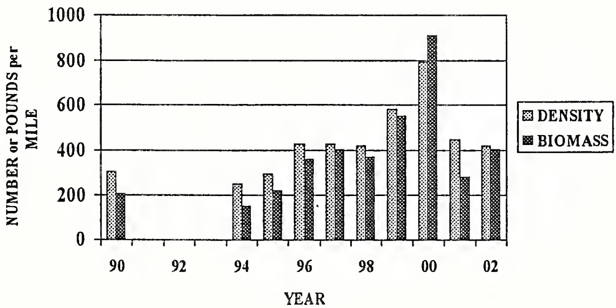

Figure 53. Estimated fall densities, by length group, of Age I and older brown trout in the Greenhorn Section of the Ruby River, 1990 - 2002.

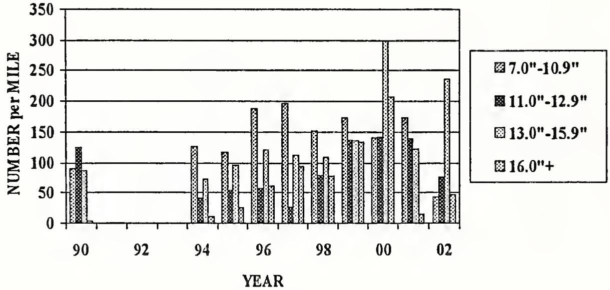

Figure 54. Mean nonirrigation season (November - March) flow (cfs) in the lower Ruby River below Ruby Reservoir Dam measured at the USGS Gage compared with the Minimum Recommended Flow (WETP Method); Water Years 1995 - 2002.

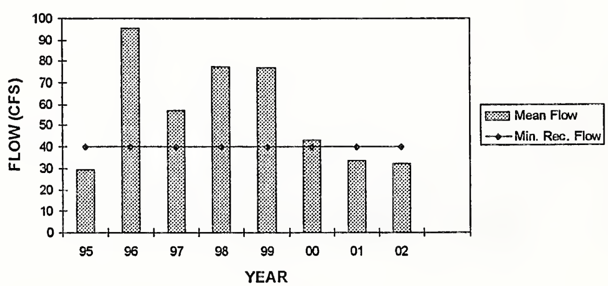

Figure 55. Estimated density and standing crop of fall Age I and older brown trout in the Passamari (PASS) Section (1994 - 1997) and spring Age II and older brown trout in the Maloney (MAL) Section (1998 - 2002) of the Ruby River.

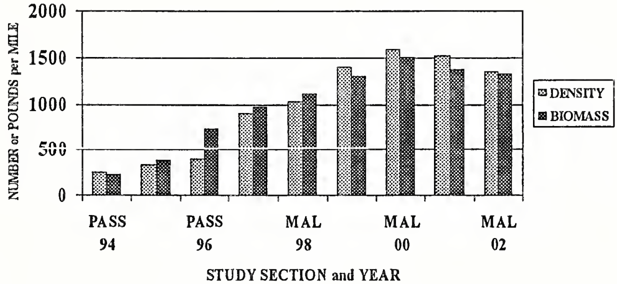

Figure 56. Estimated densities of 13 inch and larger brown trout from fall samples in the Passamari (PASS) Section and spring samples in the Maloney (MAL) Section of the Ruby River, 1994 - 2002.

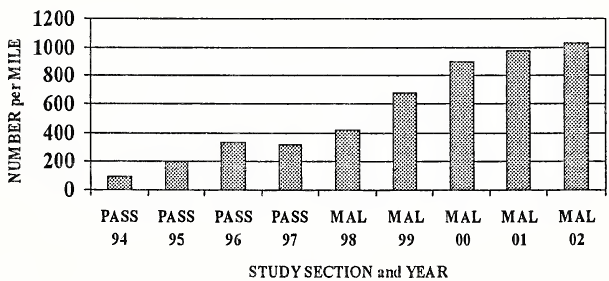

Figure 57. Estimated densities of 18 inch and larger brown trout from fall samples in the Passamari (PASS) Section and spring samples in the Maloney (MAL) Section of the Ruby River, 1994 - 2002.

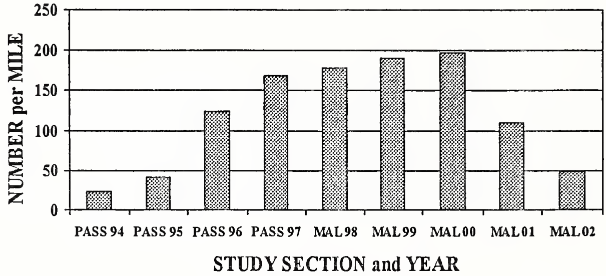

Figure 58. Estimated densities of juvenile brown trout from fall samples of Age I fish in the Passamari (PASS) Section and spring samples of Age II fish in the Maloney (MAL) Section of the Ruby River, 1994 - 2002.

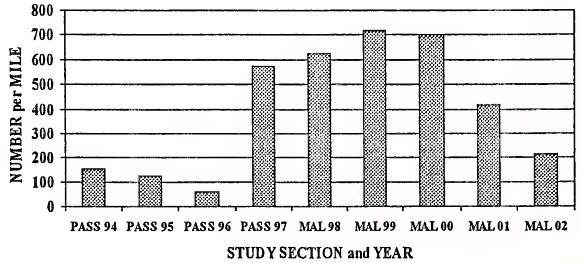

Figure 59. Mean spring Condition Factor (K) for Age II and older brown trout and 18 inch and larger brown trout in the Maloney Study Section of the Ruby River 1999 - 2002.

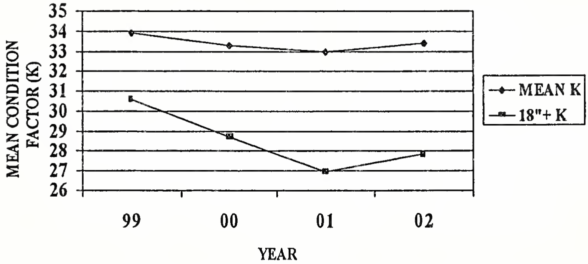

Figure 60. Estimated spring density and standing crop of Age II and older brown trout in the Silver Spring Section of the Ruby River, 1989 - 2002.

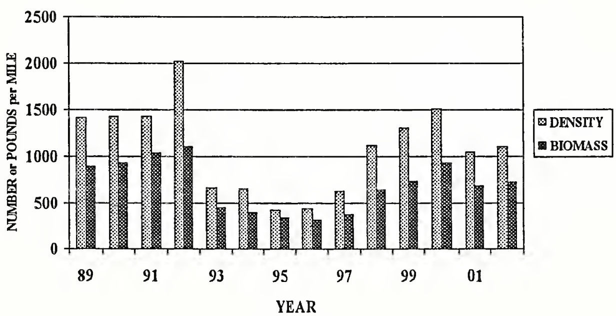

Figure 61. Estimated spring densities of juvenile (Age I and Age II) brown trout in the Silver Spring Section of the Ruby River, 1989 - 2002.

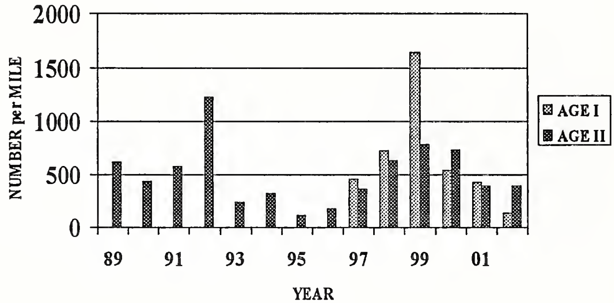

Figure 62. Estimated spring density of 13 inch and larger brown trout in the Silver Spring Section of the Ruby River, 1989 - 2002.

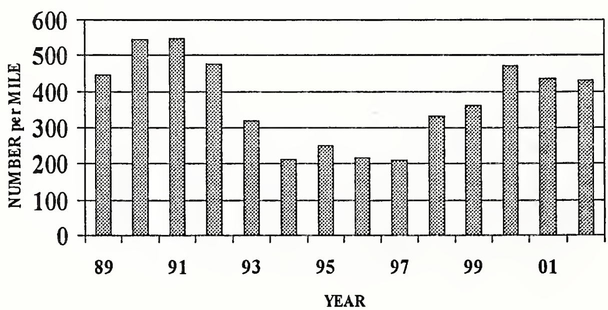

Figure 63. Estimated spring density of 16 inch and larger brown trout in the Silver Spring Section of the Ruby River, 1989 - 2002.

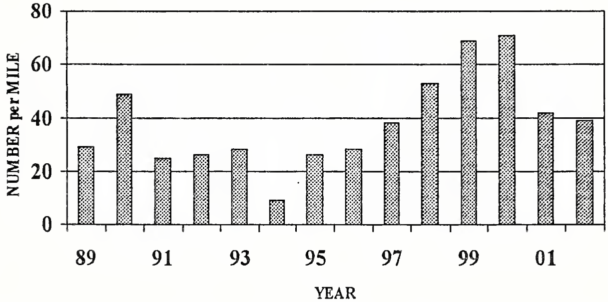

Figure 64. Estimated spring density and standing crop of Age II and older brown trout in the Sailor Section of the Ruby River, 1979 - 2000.

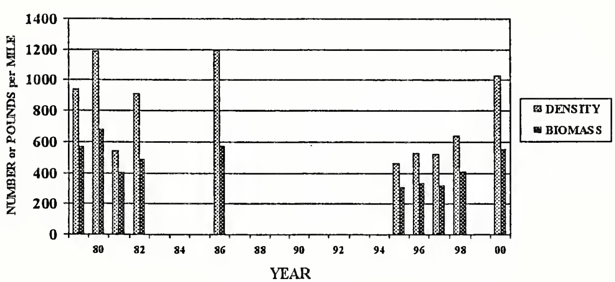

Figure 65. Estimated spring densities of juvenile (Age I and Age II) brown trout in the Sailor Section of the Ruby River, 1995 - 2000.

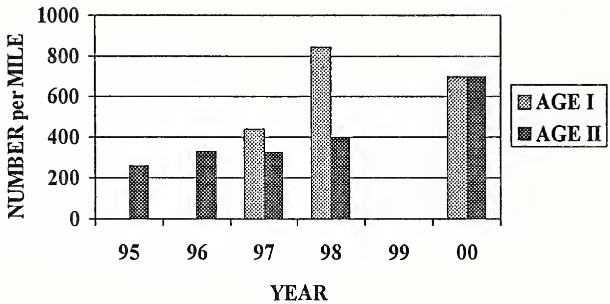

Figure 66. Estimated spring density of 13 inch and larger brown trout in the Sailor Section of the Ruby River, 1995 - 2000.

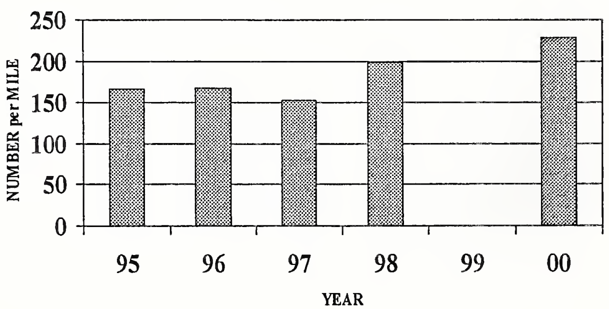

Figure 67. Estimated spring density of 16 inch and larger brown trout in the Sailor Section of the Ruby River, 1995 - 2000.

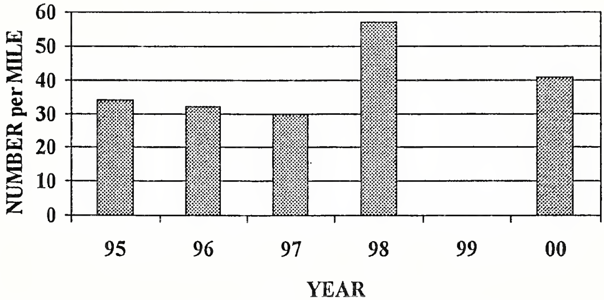

Figure 68. Estimated spring density and standing crop of Age I and older brown trout in Section Three of Poindexter Slough, 1989 - 2002.

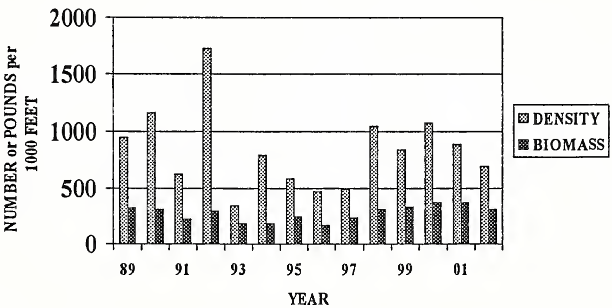

Figure 69. Estimated spring density of Age I brown trout in Section Three of Poindexter Slough, 1989 - 2002.

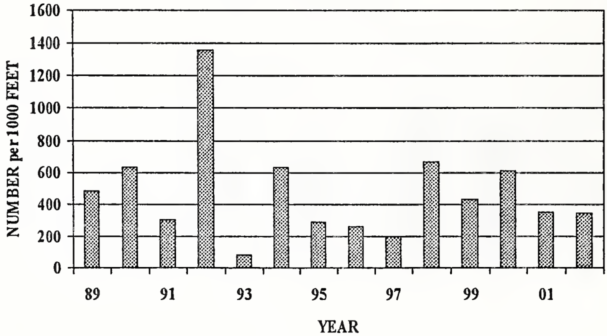

Figure 70. Estimated spring density of 13 inch and larger brown trout in Section Three of Poindexter Slough, 1989 - 2002.

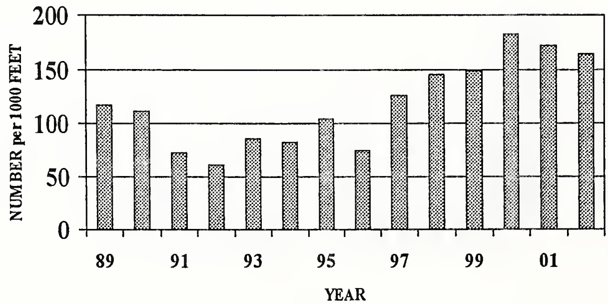

Figure 71. Estimated spring density of 15 inch and larger brown trout in Section Three of Poindexter Slough, 1989 - 2002.

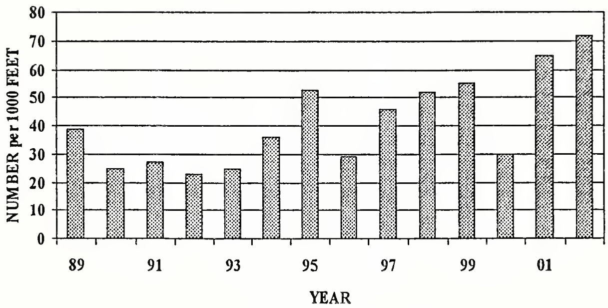

Figure 72. Estimated spring or fall density and standing crop of brown trout in the Shearing Pen Section of Big Sheep Creek, 1980, 1986, 1996 and 2000.

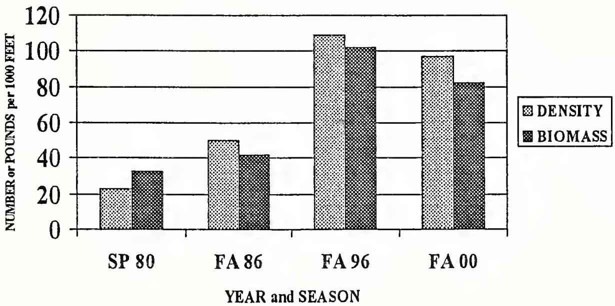

Figure 73. Estimated density of juvenile (fall Age I or spring Age II) brown trout in the Shearing Pen Section of Big Sheep Creek, 1980, 1986, 1996 and 2000.

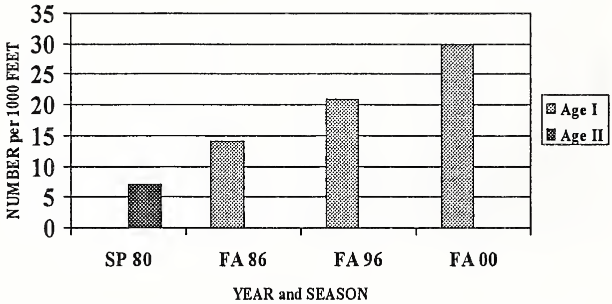

Figure 74. Estimated spring or fall densities of 13 inch and larger and 16 inch and larger brown trout in the Shearing Pen Section of Big Sheep Creek, 1980, 1986, 1996 and 2000.

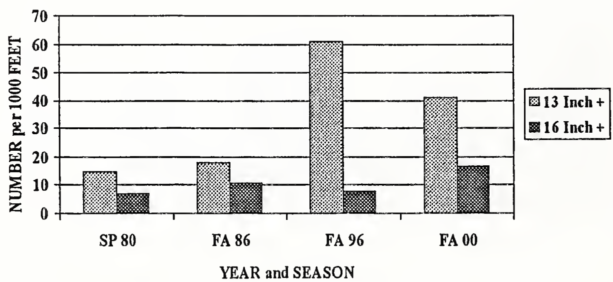

Figure 75. Estimated spring or fall density and standing crop of rainbow trout in the Shearing Pen Section of Big Sheep Creek; 1980, 1986, 1999 and 2000.

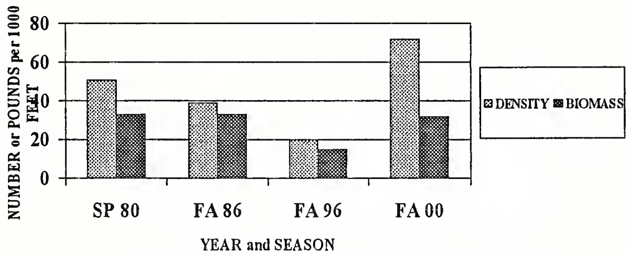

Figure 76. Estimated density of juvenile (fall Age I or spring Age II) rainbow trout in the Shearing Pen Section of Big Sheep Creek; 1980, 1986, 1996 and 2000.

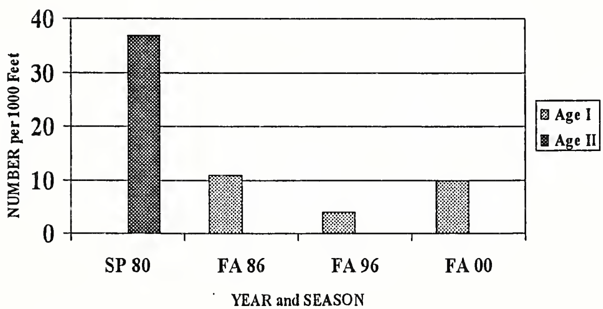

Figure 77. Estimated spring or fall densities of 13 inch and larger and 15 inch and larger rainbow trout in the Shearing Pen Section of Big Sheep Creek; 1980, 1986, 1996 and 2000.

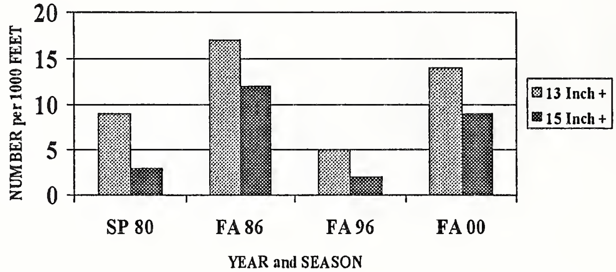

Figure 78. Estimated spring or fall density and standing crop of brown trout in the Canyon Section of Big Sheep Creek; 1982, '83, '87, '96 and 2000.

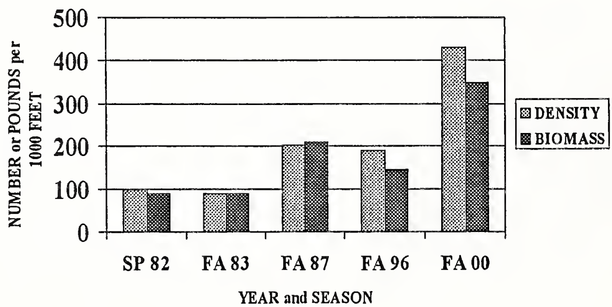

Figure 79. Estimated spring or fall density of juvenile (fall Age I or spring Age II) brown trout in the Canyon Section of Big Sheep Creek; 1982, '83, '87, and '96 and 2000.

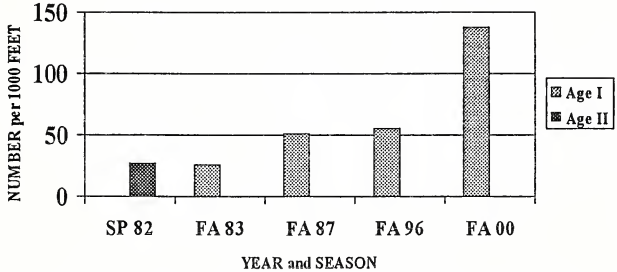

Figure 80. Estimated spring or fall densities of 13 inch and larger and 16 inch and larger brown trout in the Canyon Section of Big Sheep Creek; 1982, '83, '87, '96 and 2000.

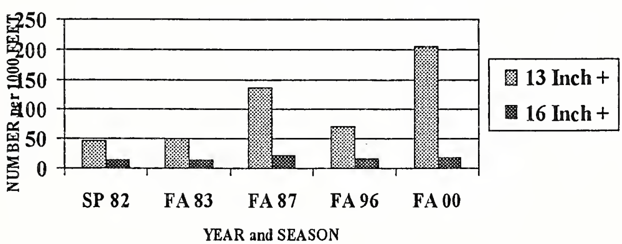

Figure 81. Estimated spring or fall density and standing crop of rainbow trout in the Canyon Section of Big Sheep Creek; 1982, '83, '87, '96 and 2000.

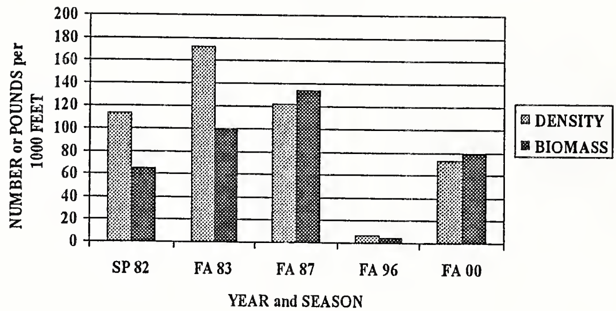

Figure 82. Estimated density of juvenile (fall Age I or spring Age II) rainbow trout in the Canyon Section of Big Sheep Creek; 1982, '83, '87, '96 and 2000.

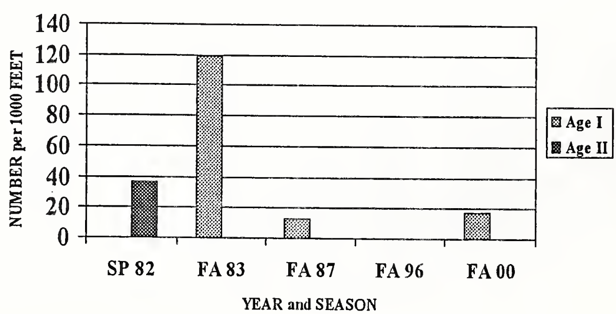

Figure 83. Estimated spring or fall densities of 13 inch and larger and 15 inch and larger rainbow trout in the Canyon Section of Big Sheep Creek; 1982, '83, '87, '96 and 2000.

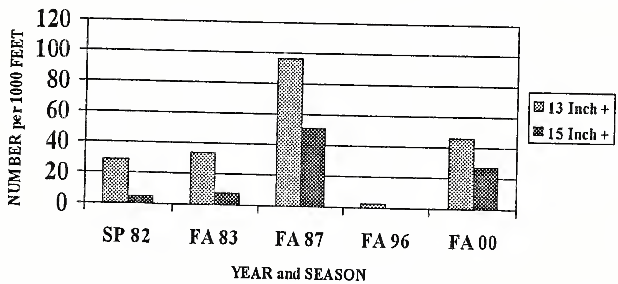

Figure 84. Estimated fall number and standing crop of westslope cutthroat trout and brook trout in the Taft Section of O'Dell Creek, 1994 and 2000.

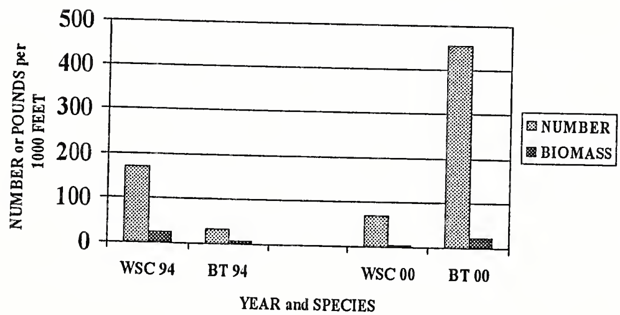

Figure 85. Estimated fall numbers, by length group, of westslope cuttroat trout and brook trout in the Taft Section of O'Dell Creek, 1994 and 2000.